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A PLETHYSMOGRAPHIC STUDY OF ATTENTION.[1]

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[1] From the Psychological Laboratory of Cornell University.

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A. Introduction.

1. *Reasons for the failure of the method of expression as applied to the study of the feelings.*

If the success of a scientific method is to be tested by the consensus of result which follows its application, the method of expression as applied to the study of the feelings must be pronounced a failure.[1] The failure is the more surprising, since the method seemed well adapted to its purpose. The organic concomitants of emotive phenomena are so patent, that they in themselves seemed to assure the effectiveness of the method; and, furthermore, in the case of the simpler affective processes, evolutionary theory seemed to indicate a logical ground. Although the conception of the method is supported by common observation and by theory, a long series of investigations has ended in contradictory or negative results. This failure of the method of expression cannot be attributed to the instruments at its disposal, because they are as perfect as the present state of physiology permits. Nor is it likely that the experimenters have been at fault. The causes must be sought elsewhere. Two possible causes suggest themselves: (i) the complication of affective processes by other mental processes; (ii) the purely physiological processes set up by the stimulus itself. If the method is to be made serviceable for the study of affective processes, the results of these two factors must be known and must be taken account of.

[1] See Appendix, for proof of this statement.

Already something has been done towards the study of these two factors. Mosso, Gley, Féré, and Delabarre have all studied the effects of intellectual activity as something different from the effects of the feelings or emotions. So, also, have Binet and Angell. McDougall has made a special study of the physiological characteristics of states of attention. Lehmann devotes, in his later work, a chapter each to the feelings and to attention and their relations. Recently, Zoneff and Meumann have approached more closely the relation of attention to affection. But with the exception of the last two references the aim of this work has been to apply the method of expression to another mental phenomenon, and not to see how far the expression of affective processes is being masked by the expression of other mental processes. The second factor has been greatly neglected. Mentz, in 1895, made a long study of the effects of auditory stimuli on pulse and respiration, with the result that auditory excitations cause a slowing of pulse and respiration, independently of any mental process. So also, in his second work, did Lehmann determine the purely physiological effects of certain stimuli. Very lately, Kelchner has raised the question how much of the effect of the method of expression is due to the stimulus and how much to the mental process. The aim of the present study is to add something to the knowledge of these two factors, with a view to forcing either the rehabilitation of the method of expression or its final abandonment. It should be understood that we did not attempt a psychological analysis of attention. Introspection was incidental rather than essential to our method. Our interest was chiefly psychophysical. We wished to know what physiological concomitants those states have, which without too much refinement of definition may be fairly characterized as states of active attention. The experimental material was obtained from a detailed study of attention under a great variety of conditions, by means of the expressive method.

2. *Apparatus and conditions of experimentation.* The instruments used in this work were Lehmann's plethysmograph and the Verdin pneumograph. The volume curve furnished the change in rate of pulse as well as the changes in volume. The measurement of the pulse rates from the plethysmogram seems to be warranted by the practice of Lehmann, and of Angell and McLennan. Both recorded the radial pulse on the one arm while the volume of the other arm was being recorded. But as no essential difference came out between the measurements of the two curves, the sphygmograph was not often used. The height of water in the manometer of the plethysmograph which was found to yield the optimal height of pulse was about 18 cm. The temperature of the water was

kept as near 37° Centigrade as was possible. The plethysmograph was always placed on the right arm. The left hand held the key of an electromagnetic signal. The pneumograph was applied to the lower thorax in the case of male observers, and to the upper thorax in the case of female observers. Both the pneumograph and the plethysmograph were connected with their respective Marey tambours by a thick walled rubber tube 1 meter long, with a lumen 4 mm. in diameter. The length of the writing lever for the pneumograph tambour was 230 mm. The distance from the fulcrum to the point at which the force was applied was 6 mm. The magnification of the curve was, therefore, 38 times. The corresponding dimensions for the lever of the plethysmograph tambour were 235 mm. and 8 mm. The magnification, therefore, was 29 times.

The records were taken on a clock-work kymograph made by C. H. Stoelting. The drum was 28 cm. long and 15 cm. in diameter. With the middle rate of revolution, the period of the drum was, approximately, 140 seconds. The mean variation of the kymograph was determined by measuring the number of seconds that fell within a 30 mm. space. The number of seconds varied about 9 as a norm. When the drum was first wound up and stopped after each revolution, the value fell slightly below 9. After 20 minutes of continuous running the value was slightly above 9. Under the former condition the mean variation was 0.12; under the latter, 0.08. The experiments were all made under the former condition. One electromagnetic signal was made to serve three purposes. It served to mark time in seconds from a Zimmerman clock; it served also as a signal for both experimenter and observer. In the two latter cases, a closure of the circuit prevented the making of seconds, so that a dash appeared in the time line. Since only 1 or 2 seconds were ordinarily obliterated, they could easily be interpolated when the reaction was measured. This arrangement saves space on the drum, and for the conditions of our experiments was without any essential error. Each record, therefore, consisted of three curves (counting from above downward), pneumogram, plethysmogram, and the combined time and signal line. The pneumograph tambour was inverted in order to close up the gap between the pneumogram and the plethysmogram. This fact must be taken into account in reading the pneumogram, since an up stroke of the stylus means an inspiration, while a down stroke means expiration.

With these instruments and conditions four physiological characters were determined in each curve; rate and depth of respiration, rate of pulse, and volume of the arm. Height of pulse was not attended to, as we did not consider the apparatus

reliable for that determination. The rates of respiration and pulse were measured by counting the number of respirations and pulses that fell within a 10 second interval. This interval was determined by erecting, at every 11th second, a vertical on the time line. The space, therefore, between two successive verticals represents 10 seconds. The changes in volume and depth of respiration were determined by inspection. A decrease in the height of the breathing curve is always spoken of as 'inhibited breathing.' Each record has 3 periods: the normal or indifferent period, the reaction period, and the period of recovery. It was attempted to make each period 40 seconds in length; but this was not feasible in some experiments. For short reaction periods, the rates were measured in 5 second intervals. In such cases, the results were multiplied by 2, so as to make the averages comparable with the averages of the normal and recovery periods, which were measured in 10 second intervals.

The following observers shared in the experiments: Drs. Bentley and Baird, Miss Jenkins and Miss Andrus, Messrs. Sabine and Galloway. Mr. Galloway began to observe with Exp. 57. Miss Andrus did not observe after Exp. 36. The normal curves of Dr. Baird, Miss Andrus, Miss Jenkins and Mr. Sabine were recorded for a period of several months prior to the experiments with reactions. The average rates of pulse and respiration, with the mean variation of each, are given in a table. The numbers which enter into these averages were obtained by measuring the number of pulses and respirations for each 10 seconds of each record. The average rate for each record is found by taking the average of the 10 second values. The final average for each observer is made by taking the average of all the records. The mean variation is the average deviation of the average of each record from the average of all the records. The number of records of both pulse and respiration is also given.

Observer	R	P	*MV* of R	*MV* of P	No. of R	No. of P
Sabine	3.06	12.8	0.138	1.21	42	39
Miss Andrus	2.58	14.6	0.199	1.31	34	33
Miss Jenkins	3.24	11.5	0.237	0.24	26	20
Baird	1.83	10.0	0.123	0.43	9	9

This table not only brings out marked individual differences in the normal rates of *P* and *R*, but the mean variations

show the degree of susceptibility to spontaneous variation of different observers. Experiments were made once or twice a week at the same time of day for each observer. These hours were 12-1, 3-4, and 4-5 P. M. The observers were comfortably seated, holding a signal key in the left hand. A curtain shut off the kymograph and experimenter from the view of the observer. Two or three records were made at each hour.

Some abbreviations and terms used in the description of the experiments require explantion. Each experiment is divided, as we have said, into three parts: normal, reaction, and recovery. An unequivocal change in the reaction value of pulse and respiration means a change which differs absolutely from the rates of both normal and recovery. For example: an unequivocal increase in the rate of pulse means an increase over both the normal and recovery rates. An equivocal change in the reaction rate is one that does not differ absolutely from both normal and recovery rates. For example, the reaction rate may be faster than normal, but slower than recovery; or slower than normal, and faster than recovery. It is a question of some importance to know how to treat these equivocal reactions. *R* stands for respiration; *P* for pulse; *V* for volume. The length of time of each period is given in seconds above the measurements for each period. The average rates of *R* and *P* are given below the measurements for each period. For example, in Exp. 1, the normal period was 85 seconds long; the reaction 35 seconds; the recovery 30 seconds. The figures standing opposite *R* and *P* are the number of respirations or pulses which occur in ten seconds. A blank in a series of figures means that the curve, for some reason, was not legible. 3.5, 3.7, 3.8, are the average rates of *R* for the three periods of the experiment. 13.7, 13.3, 12.8, are corresponding values for *P*. The changes in depth of breathing and volume are given in words. It will be seen that the reaction of both *P* and *R* in this experiment is equivocal. *O* stands for observer; *E* for experimenter.

B. Experiments on the State of Attention.

I. Attention to Visual Stimuli.

1. Stimulus: A Masson Disc. The disc was rotated on a hand color mixer. *O* attended to the fluctuations of one of the rings.

Exp. 1. Sabine.

				1″—85″				
R	3.00	4.00	3.50	4.75	3.25	3.75	3.00	3.00
P	——	12.5	15.0	14.0	14.0	14.5	13.0	13.0
				3.5				
				13.7				

1″— 35″				1″— 30″		
4.00	3.50	3.75	3.75	4.25	3.25	4.00
14.0	13.5	13.0	13.0	13.5	13.0	12.0
		3.5			3.8	
		13.3			12.8	

During reaction: *R* is somewhat inhibited; there is one deep inspiration.

V falls slowly to the end of reaction; then rises during recovery.

EXP. 2. SABINE.

	1″— 49″					1″— 32″				
R	3.50	3.50	3.50	3.25	3.75	3.50	4.00	3.75	3.50	3.50
P	12.0	12.0	12.5	12.5	12.5	12.0	13.0	12.5	12.0	12.5
			3.5					3.6		
			12.3					12.4		

1″— 30″				
3.25	2.75	3.00	3.25	3.25
12.0	12.5	12.0	12.0	12.0
		3.1		
		12.1		

During reaction: 2 *R* are inhibited (just after signal); for 20″ depth is normal; then 4 hypernormal *R* followed by 3 inhibited *R*.

V falls slowly throughout reaction; reaches minimum at end of reaction; rises during recovery.

EXP. 3. SABINE.

	1″—39″				1″—42″				
R	3.50	3.50	3.00	3.50	3.75	3.75	3.75	4.00	3.75
P	——	11.5	13.0	12.0	13.5	14.0	14.0	13.0	12.5
		3.5					3.8		
		12.1					13.4		

1″—60″						
3.25	3.25	3.50	3.25	3.50	3.25	——
12.0	12.5	11.5	12.0	11.5	11.5	11.6
		3.3				
		11.8				

During reaction: 1 *R* is deeper than normal; inhibition sets in and reaches maximum at the middle of reaction. It gradually lessens to the end of reaction.

V falls slightly after first signal, rises, then falls steadily to near the end of reaction. It rises sharply and steadily during recovery.

EXP. 4. MISS JENKINS.

	1″— 39″				1″— 55″					
R	3.30	3.00	3.45	3.27	3.60	4.00	3.95	3.95	3.80	3.40
P	11.5	11.5	12.5	12.3	12.5	13.0	12.5	12.0	11.5	12.0
		3.27					3.78			
		11.9					12.2			

1″— 38″			
4.05	3.40	3.05	3.37
12.0	11.5	11.5	11.8
	3.46		
	11.7		

During reaction: *R* is inhibited; inhibition seems to pass off toward the end of the reaction.

V does not fall immediately; falls suddenly and remains low for 15″; rises to end of reaction.

EXP. 5. MISS JENKINS.

1″— 62″

R	3.40	3.20	3.50	3.75	3.50	3.75
P	12.0	——	12.5	12.5	12.0	11.2

3.51
12.2

1″— 36″

3.75	4.00	4.00	3.75
12.0	12.5	13.0	12.5

3.87
12.5

1″— 35″

4.25	3.70	4.00	3.60
13.5	11.5	13.0	12.0

3.88
12.5

During reaction: *R* is slightly inhibited.

V is not very constant. After the beginning, it falls slightly; rises to a first maximum; falls slowly to the middle of the reaction; then rises to a second maximum at the end of the reaction.

EXP. 6. MISS JENKINS.

1″—35″

R	3.75	3.75	3.75	3.80
P	13.0	12.0	12.5	12.0

3.76
12.3

1″— 35″

4.05	3.95	4.00	4.00
12.5	12.0	12.0	12.0

4.00
12.1

1″— 56″

3.75	4.10	4.00	3.25	3.90	3.50
13.0	13.0	12.5	11.5	12.5	10.7

3.75
12.2

During reaction: *R* is slightly inhibited.

V rises 20″ after the beginning of the reaction and continues high until 10″ after reaction.

EXP. 7. MISS ANDRUS.

1″— 53″

R	3.10	3.30	2.25	2.75	3.45	2.50
P	——	12.0	12.0	12.0	13.0	13.3

2.90
12.0

1″— 35″

3.50	3.35	3.90	3.00
13.2	13.0	13.5	14.0

3.43
13.4

1″— 38″

3.75	3.00	3.00	3.00
13.0	12.75	12.0	11.25

3.18
12.2

During reaction: *R* is inhibited at first. There are then 2 hypernormal *R;* 2 normal *R;* and 2 inhibited.

V does not change. The plethysmograph functioned as a sphygmograph.

EXP. 8. MISS ANDRUS.

	1″— 40″				1″— 36.5″			
R	2.80	2.50	2.70	3.10	2.95	2.95	3.00	3.08
P	10.5	10.0	11.0	11.0	11.5	11.5	11.0	12.3
		2.83				2.99		
		10.6				11.5		

1″— 59.5″

R	1.75	1.80	2.25	2.00	2.75	2.87
P	11.0	11.0	11.0	11.0	11.0	11.1

2.23
11.0

During reaction: the height of *R* is increased.
V is diminished.

EXP. 9. BAIRD.

	1″— 40″				1″— 39″			
R	2.25	1.90	1.85	1.75	2.25	2.25	2.35	2.50
		1.92				2.43		

1″— 50″

2.75 2.25 2.50 2.05 2.20

2.35

During reaction: *R* is greatly inhibited. *V* is diminished. (*P* is not legible.)

EXP. 10. SABINE.

	1″—48″					1″—32.5″			
R	3.00	2.75	2.90	3.45	3.43	3.60	3.65	3.55	3.33
P	——	13.5	13.5	13.0	13.7	14.0	14.0	14.0	15.0
			3.14				3.53		
			13.4				14.2		

1′—51.5″

3.50	3.25	3.20	3.00	3.00	3.00
13.7	13.5	14.0	13.5	12.5	13.0

3.31
13.3

During reaction: *R* is inhibited after the first and the second signals.
V falls to a low level in the middle of the reaction and rises to the end of reaction.

EXP. 11. SABINE.

	1′—34″				1′—32.5″			
R	3.25	3.15	3.01	3.65	3.35	3.55	3.40	3.60
P	14.0	13.2	13.5	14.4	13.2	12.7	13.5	16.0
		3.27				3.47		
		13.7				13.8		

1′—77.5″

3.75	3.20	3.50	3.15	3.30	3.00	3.07
13.5	13.7	14.0	14.0	13.0	13.0	13.0

3.28
13.4

During reaction: *R* is inhibited more during the first half of reaction than the last.
V is diminished during the reaction.

EXP. 12. BAIRD.

1″—42″

R	2.6	2.6	2.4	2.6	2.5
P	10.5	10.5	10.2	10.5	10.0

2.54
10.3

1′—48″

2.6	2.2	2.6	2.4	2.5
10.2	10.7	10.5	10.5	10.0

2.47
10.4

1″—40″

2.6	2.4	2.4	2.5	
10.0	10.0	10.0	10.0	

2.47
10.0

During reaction: *R* is inhibited.
V falls during reaction. It begins to rise 10″ after reaction.

EXP. 13. BAIRD.

1″—40″

R	2.4	2.6	2.4	2.5
P	10.2	10.2	10.2	10.0

2.47
10.8

1″—40″

2.6	2.5	2.5	2.5	
10.5	10.0	10.0	10.0	

2.54
10.1

1″—60″

2.5	2.4	2.5	2.2	2.4
10.0	10.0	10.0	10.2	10.2

2.42
10.1

During reaction: *R* is inhibited.
V is diminished.
The respiratory oscillation which was very marked during normal and recovery was suppressed during reaction.

EXP. 14. BAIRD.

1″—40″

R	2.5	2.2	2.6	2.6
P	10.2	9.7	10.0	10.0

2.48
10.0

1′—46″

2.6	2.7	2.5	2.4	2.3	
10.0	9.2	9.5	10.2	10.4	

2.51
9.8

1″—47″

2.7	2.4	2.7	2.4	2.5
10.5	10.0	10.0	10.0	10.0

2.56
10.1

During reaction: *R* is inhibited, more in the middle than at the beginning.
V falls somewhat after first signal; but rises before the end of the reaction.
The respiratory oscillation is suppressed.

Summary of Results.

Attention to *Masson disc* is characterized by

i. Unequivocally increased rate of *R* (10 cases out of 14). In 3 cases *R* is greater than normal and less than recovery; in 1 case less than normal and the same as recovery.

ii. Unequivocally increased rate of *P* (8 cases out of 14). In 1 case less than recovery and greater than normal. In 2 cases less than normal and greater than recovery. In 2 cases unequivocally slowed. In 1 case no experiment.

iii. Inhibited breathing. (In part in every experiment.)

iv. A fall in volume of the forearm. (In all cases except Exp. 6, in which *V* rises.)

2. Stimulus: Black Paper and After-Image.

Attention was directed to an oblong piece of velvet-black paper, 4 x 3.5 cm., exposed on a gray background. *O* fixated the paper for 15-20 seconds; then watched the development of the after-image on the screen. Both fixation and after-image phases are included in the attention period. The measurements of the fixation and after-image phases are separated within the total reaction, by a line of vertical dots. The average rates of *P* and *R* for each phase are to be found at the two ends of the reaction period. The average rates of *P* and *R* for the reaction considered as a whole are given between the averages for the fixation and after-image phases. For example, in Exp. 15, the average rate of *R* and *P* for the fixation phase of the reaction is 4.00 and 11.8 respectively; for the after-image phase, the rate of *R* and *P* is 3.63 and 11.8 respectively; for the reaction as a whole, the values are 3.87 and 11.8. In any general discussion of the results of these experiments only the last values are considered.

EXP. 15. MISS JENKINS.

	1″— 69″							1″— 20″		1″— 11″
R	3.30	3.60	3.40	3.00	3.90	3.80	3.60	4.25	3.75 :	3.63
P	12.0	12.6	12.0	12.0	12.0	11.7	12.2	12.0	11.7 :	11.8
			3.52					4.00	3.87	3.63
			12.0					11.8	11.8	11.8

1″— 37″

3.95	3.60	3.60	4.00
12.0	12.0	12.0	11.4

3.78
11.8

During reaction: *R* is inhibited during fixation; but not during after image.

V falls after the first signal at the beginning of the reaction, and rises again to normal level. It falls at the end of the reaction.

EXP. 16. MISS JENKINS.

1″— 65″

R	——	——	3.75	3.50	3.90	4.00	4.00
P	——	——	12.0	11.75	12.0	12.0	12.5

3.83
12.0

1″— 20″			1″— 20″			1″— 29″		
3·90	4·00	:	3·2	4·2	3·75	3·90	3·66
12·0	12·75	:	12·0	12·0	12·0	12·0	11·6
	3·95	3·86	3·70			3·77	
	12·0	12·1	12·0			11·8	

During reaction: R is inhibited during fixation; there is a short period of deeper breathing between fixation period and after-image; the breathing is inhibited during after-image. V falls at the beginning and the end of the reaction with normal level between. During the normal period, there was a decided fall in V about 15 seconds before reaction; V returned to the normal level before the reaction. O reported that she looked at the screen and expected E to move it.

EXP. 17. MISS JENKINS.

1″— 58″

R	3·50	3·80	3·00	3·60	3·80	3·75
P	11·0	12·0	11·5	12·0	11·0	11·0

3·57
11·4

1″— 22″			1″—21″		1″— 34″			
3·60	3·75	3·40 :	3·80	3·60	3·90	3·75	3·75	3·75
11·5	11·5	12·0 :	11·5	10·8	11·5	11·5	11·5	11·5
	3·58	3·63	3·70			3·78		
	11·6	11·4	11·1			11·4		

During reaction: height of R is not much changed. V falls after each signal (at the beginning and the end of the reaction), with normal level between. During the normal, there was a noise made by a falling body. This disturbance may account for the increase in rate of P in the middle of the normal.

EXP. 18. BAIRD.

	1″— 40″				1″— 33″			1″— 21″		
R	2·50	2·30	2·20	2·00	2·50	2·30	2·25 :	2·55	2·45	2·40
P	10·0	10·5	10·75	10·25	10·2	10·5	10·75 :	10·25	10·5	11·0
		2·25				2·35	2·40	2·46		
		10·3				10·4	10·5	10·5		

1″— 40″

2·00	1·50	2·00	1·80
10·25	10·25	10·0	10·0

1·82
10·1

During reaction: R is inhibited strongly during fixation; somewhat less during after-image.

V remains nearly level throughout; there are marked respiratory oscillations during normal and recovery; these are suppressed almost entirely during fixation. They are not so much suppressed during after-image.

EXP. 19. BAIRD.

1″—39″

R	2·55	2·40	2·50	2·80
P	10·5	11·0	10·75	11·0

2·56
10·8

1″—37″					1″—27″					1″—30″		
2.25	2.40	2.30	2.60	:	2.50	2.30	2.30	2.00		2.00	1.90	1.90
10.6	10.5	10.0	10.5	:	9.0	11.0	10.5	10.0		11.0	10.5	10.00
	2.38		2.31			2.27					1.93	
	10.4		10.5			10.1					10.1	

During reaction: *R* is inhibited strongly during fixation; somewhat less during after-image. There are no changes in *V*, as the plethysmograph functioned as a sphygmograph.

EXP. 20. BAIRD.

	1″—40″				1″—42″						1″—19″	
R	2.50	2.40	2.10	2.60	2.25	2.25	2.90	2.50	2.60	: 2.30	2.50	
P	11.0	11.0	11.5	11.75	11.25	10.0	10.75	10.5	10.75	: 10.25	10.0	
		2.43				2.50		2.47		2.40		
		11.3				10.6		10.5		10.1		

1″—34″			
2.0	1.9	1.6	1.5
10.5	10.25	9.5	10.0
	1.75		
	10.0		

During reaction: *R* is inhibited strongly during fixation; less strongly (but still inhibited) during after-image. *V* rises during fixation; falls before the end of fixation; rises during after-image.

EXP. 21. SABINE.

	1″—40″			
R	3.4	2.75	3.4	3.5
P	14.5	15.75	15.5	14.75
		3.25		
		15.1		

1″—40″					1″—30″				1″—30″		
3.30	3.40	3.45	3.25	:	3.45	2.60	3.10		2.9	3.00	3.25
14.5	14.25	15.0	15.25	:	13.25	14.0	14.0		15.0	15.5	14.75
	3.36		3.20			3.05				3.05	
	14.5		14.1			13.7				15.0	

During reaction: height of *R* is irregular; there is no change during fixation; but there is considerable inhibition during first half of after-image, although less during latter part. *V* falls during first part of fixation, rising to normal during latter part of fixation. It falls during the after-image and remains low throughout the rest of the reaction. It rises during recovery. *O* reports the most vivid after-image he ever saw. He was surprised and pleased.

EXP. 22. SABINE.

	1″—40″				1″—34″				1″—22″		
R	1.60	2.45	2.10	3.00	3.10	3.50	2.60	:	3.40	3.40	3.10
P	17.0	15.5	14.5	14.5	14.2	15.0	16.5	:	14.0	14.2	13.7
		2.28				3.00			3.10		3.20
		15.3				15.2			14.5		13.9

1″—40″			
3.30	2.25	3.00	3.00
14.7	15.5	14.5	14.5
	2.80		
	14.8		

During reaction: *R* is inhibited as compared with the height of *R* in recovery. On the whole, there is a fall in *V*.

EXP. 23. SABINE.

1″—53″

R	2.50	3.00	3.00	3.00	3.10	2.60
P	15.0	14.25	13.2	14.2	14.5	12.5

2.80
13.8

1″—30″			1″— 22″			1″— 30″		
2.65	2.90	3.10	3.00	3.00	3.75	3.25	3.20	3.30
——	15.25	14.75	13.5	13.75	13.0	14.75	15.25	14.0
		2.80	3.02	3.25			3.25	
		14.8	14.1	13.4			14.6	

During reaction: *R* is markedly inhibited during after-image; but not during fixation. *V* falls after the initial and the final signals of the reaction.

EXP. 24. MISS ANDRUS.

1″— 42.5″

R	3.00	3.30	3.20	3.20
P	13.8	15.1	15.1	14.2

3.17
14.5

1″— 29.5″			1″— 50″					
2.94	3.05	3.33	3.45	3.45	3.25	3.25	3.20	No
14.2	15.0	15.5	15.0	14.7	15.0	14.6	15.1	recovery
		3.10	3.21	3.32				
		14.9	14.8	14.8				

During reaction: *R* is not changed during fixation, but it is deeper and more regular during after-image. *V* falls at the beginning and end of fixation; it is normal between. There is a gradual fall in *V* during the after-image.

EXP. 25. MISS ANDRUS.

1″— 46″

R	3.10	2.90	2.75	3.00	3.20
P	15.0	15.0	14.4	14.8	14.6

2.99
14.7

1″— 17″			1″— 29.5″			1″— 33″		
3.05	2.85	2.95	3.05	3.10	3.33	2.75	3.10
14.4	13.8	13.7	14.3	14.4	13.3	13.5	13.8
	2.95	3.03				3.06	
	14.1	14.1				13.5	

During reaction: *R* is inhibited during fixation and the first part of after-image. *V* is subnormal, with marked depressions after the beginning and the end of the reaction.

EXP. 26. MISS ANDRUS.

	1″— 44″				1″— 14″		1″— 25″	
R	3.40	2.80	2.90	3.35	3.23	3.25	3.20	3.00
P	14.0	13.6	14.0	15.0	13.5	13.8	14.6	13.2
		3.11				3.23	3.19	3.15
		14.1				13.5	13.7	13.9

1″— 45″

3.00	2.90	3.05	3.45	2.10
13.7	12.8	13.0	13.6	12.0

2.90
13.0

During reaction: on the whole, there is a fall in V, with sudden dips at the beginning and the end of the reaction. R is inhibited during fixation, although it is normal for after-image.

Summary of Results.

Attention to stimulus and after-image is characterized by

i. Unequivocally increased rate of R (8 out of 12 cases).

In 2 cases R is less than normal, but greater than recovery.

In 1 case R is same as normal, but less than recovery.

In 1 case R is greater than normal, and less than recovery.

For the unequivocal increases in rate of R, the fixation rate is greater in four cases and the after-image greater in four cases. In the two cases where reaction is less than normal but greater than recovery, R during fixation is faster than during after-image. In the two cases where reaction is the same or greater than normal but less than recovery, the rate of R for after-image is greater. In six cases each, is the respiration rate faster, during fixation and after-image.

ii. Unequivocal increase in the rate of P (3 out of 12 cases).

In 5 cases P is greater than recovery, but less than normal.

In 1 case P is greater than normal, but less than recovery.

In 2 cases P is unequivocally less than either normal or recovery.

In 1 case P is greater than normal; but there is no recovery in that experiment.

For the unequivocal increase in rate of P, fixation rate is faster in two cases. For the cases where P is greater than recovery but less than normal, the fixation rate is faster in three cases, the same in one case, slower than the after-image rate in one case. For the one case of reaction P less than recovery but more than normal, fixation rate is greater. For the two cases of unequivocal slowing, fixation is faster. For the case where there is no recovery, fixation is faster. In all, fixation P is faster than after-image P in 9 cases, slower in two cases, same in one case.

iii. Inhibited breathing in nearly every case; more in fixation than in after-image.

iv. Lower level of V of arm. In one case (exp. 20) there is a rise in V during fixation. In most experiments, there is a sudden fall in V at the beginning and end of reaction with normal level between.

3. Stimulus: Closely drawn radii of circle. O was asked

to count the number of radii. There were 69 drawn in a circle about 10 cm. in diameter.

EXP. 27. SABINE.

	1″—40″				1″—40″			
R	3·30	3·45	3·25	2·75	3·25	3·25	3·30	3·20
P	——	——	13·5	14·75	13·0	13·0	12·5	12·5
	3·18				3·27			
	14·1				12·7			

1″—37″

3·40	3·40	2·60	3·23
13·5	13·75	13·5	14·4

3·15
13·7

During reaction: *R* is more regular and perhaps slightly inhibited. *V* falls. The respiratory oscillation is suppressed.

EXP. 28. SABINE.

	1″—40″				1″—42″			
R	3·20	3·30	3·00	3·0	3·55	3·46	3·10	3·27
P	13·0	12·5	12·5	12·25	13·75	13·25	13·0	12·7
	3·01				3·34			
	12·5				13·0			

1″—40″

3·00	3·05	3·05	3·30
14·5	13·75	13·0	12·5

3·10
13·3

During reaction: *R* is markedly inhibited, more at first than afterwards. *V* falls noticeably. The respiratory oscillation is suppressed.

EXP. 29. SABINE.

	1″—40″				1″—42″			
R	3·10	3·30	2·95	2·50	3·60	3·30	3·75	3·50
P	11·5	12·0	12·5	13·0	12·75	12·5	12·3	12·7
	2·96				3·53			
	12·2				12·6			

1″— 38″

3·00	2·30	2·95	3·50
13·75	13·5	12·75	12·8

2·93
13·2

During reaction: *R* is inhibited. *V* is diminished. The respiratory oscillation is suppressed.

EXP. 30. BAIRD.

	1″— 40″				1″— 28″			
R	2.60	2.65	2.35	2.60	2.40	2.50	2.50	2.50
P	12.0	13.0	11.75	12.5	12.0	11.75	11.75	12.1
	2.55				2.47			
	12.3				11.9			

1″— 50″

2.75	2.45	2.40	2.50	2.25
12.25	12.5	12.5	12.5	13.0

2.47
12.5

During reaction: *R* is inhibited. The plethysmograph functioned as a sphygmograph.

EXP. 31. BAIRD.

1″— 40″

R	2.40	2.10	2.45	2.40
P	12.5	12.5	12.5	12.75

2.33
12.5

1″— 40″

2.45	2.25	2.75	2.45
12.5	12.0	12.0	11.5

2.47
12.0

1″— 50″

2.60	2.45	2.45	2.25	2.65
12.5	12.0	12.0	12.25	12.5

2.48
12.5

During reaction: *R* is inhibited; *V* falls at first, but rises gradually to the end of the reaction.

EXP. 32. MISS JENKINS.

1″— 50″

R	2.80	3.05	3.15	3.50	3.45
P	——	13.5	12.75	13.0	13.0

3.19
13.0

1″— 40″

4.00	3.90	3.90	4.25
12.75	13.25	13.25	13.50

4.00
13.1

1″— 40″

4.00	3.80	3.75	3.90
13.5	13.75	13.0	13.0

3.86
13.3

During reaction: *R* is markedly inhibited. *V* is unchanged, except for a slight fall after the first signal.

EXP. 33. MISS JENKINS.

1″— 40″

R	3.70	3.85	3.80	3.00
P	13.0	12.0	13.0	13.75

3.58
12.9

1″— 40″

3.80	3.95	3.75	3.75
12.75	13.0	13.5	13.1

3.86
13.0

1″— 55″

3.70	3.75	3.50	3.55	3.60
13.75	13.5	13.5	13.5	13.0

3.60
13.4

During reaction: *R* is inhibited. *V* is very slightly diminished. The respiratory oscillation is markedly suppressed.

EXP. 34. MISS JENKINS.

	1″—40″				1″—40″			
R	3·75	3·40	3·00	3·40	3·60	3·90	3·50	3·75
P	13·5	13·5	13·5	13·0	13·0	12·75	12·0	12·5
		3·38				3·68		
		13·7				12·56		

1″—50″

3·85	3·75	3·55	3·55	3·30
12·5	12·8	12·3	12·5	12·5

3·60
12·52

During reaction: R is inhibited very slightly. The respiratory oscillation is slightly suppressed. V is not changed.

EXP. 35. MISS ANDRUS.

	1″—39″				1″—40″			
R	3·70	3·60	3·55	3·60	3·75	3·50	3·75	3·75
P	13·5	13·1	13·8	13·2	14·0	14·2	13·5	13·8
		3·61				3·69		
		13·4				13·7		

1″—40″

3·70	3·15	3·20	3·70
12·0	12·8	12·7	12·5

3·44
12·5

During reaction: height of R is increased. *Cf.* Exps. 8 and 24 for deeper breathing during attention in the same O. *Cf.* also Exps. 25 and 26 for inhibited breathing during attention. There is a marked fall in V.

EXP. 36. MISS ANDRUS.

	1″—40″				1″—40″			
R	3·40	3·35	3·00	3·05	3·30	3·35	3·35	3·40
P	13·6	12·9	12·6	13·0	13·8	14·3	14·6	14·0
		3·20				3·62		
		13·0				14·2		

1″—49″

3·30	2·25	2·50	2·95	2·90
13·5	13·1	12·0	12·7	12·9

2·74
12·8

During reaction: Height of R is increased. V is more markedly decreased than in the last experiment.

Summary of Results.

Attention involved in counting radii of circle is characterized by

i. Unequivocally increased rate of R (8 out of 10 cases). In 2 cases (same O), R is once slower than normal, but same as the recovery; and once it is greater than the normal, but very slightly less than the recovery.

ii. Unequivocal slowing of *P* (3 out of 10 cases, 2 by same *O*).

Unequivocal increase (2 out of 10 cases).

In 4 cases reaction *P* is faster than normal but slower than recovery. In 1 case, it is faster than recovery but slower than normal.

iii. Inhibited breathing (8 out of 10 cases); deepened breathing in same *O* in two instances.

iv. Suppression of respiratory oscillation where it occurs.

v. Fall in *V* (7 out of 10). 2 cases unchanged; 1 case *V* not recorded.

At this point, it was suggested that the experiments should be taken as a part of the day's work and be worked through mechanically. Two variations were devised: (i) an experiment in the performance of which *O* should have an intrinsic interest, *e. g.*, looking for an illusion in the radii of a circle; and (ii) an experiment which should involve the peculiar interests of *O; e. g.*, a question in philosophy for a student of philosophy. The first variation was carried out with the radii of a circle with a view to detecting an illusion in the lines; and also with the after-image stimulus with a view to marking the periodicity of the after-image.

4. Stimulus: Suggested Illusion in the Radii of a Circle. *O* was asked to discover the illusion.

EXP. 31. BAIRD.

	1″—48″					1″—48″				
R	2.25	2.00	2.10	2.10	2.20	2.30	2.45	2.15	2.60	2.50
P	11.0	11.0	11.0	11.0	10.9	10.5	10.6	11.0	11.0	10.3
			2.13					2.40		
			10.9					10.6		

	1″—35″			
	1.50	2.25	2.40	2.40
	11.0	10.4	10.5	19.5
		2.13		
		10.6		

During reaction: *R* is markedly inhibited. The respiratory oscillation is suppressed. There is no *V* change, since the plethysmograph functioned as a sphygmograph.

EXP. 38. BAIRD.

	1″—30″			1″—26″		
R	2.85	2.50	2.75	2.50	2.50	2.16
P	11.5	11.0	11.5	11.4	10.7	11.0
		2.70			2.38	
		11.3			11.0	

1″— 68″

2.75	2.75	2.30	2.50	2.30	2.10	2.30
11.7	11.5	11.4	10.9	11.4	11.2	11.2

2.42
11.3

During reaction: *R* is markedly inhibited. The respiratory oscillation is suppressed. The plethysmograph functioned as a sphygmograph.

EXP. 39. BAIRD.

	1″— 37″				1″— 22″		
R	2.30	2.10	2.50	2.57	2.60	2.50	2.41
P	11.0	11.6	11.5	10.7	12.0	11.5	11.6
	2.36				2.50		
	11.2				11.7		

1″— 65″

2.85	2.45	2.50	2.45	2.20	2.30	2.50	
12.0	11.0	11.3	11.0	11.0	10.8	10.6	

2.46
11.1

During reaction: *R* is greatly inhibited. The plethysmograph functioned as a sphygmograph.

EXP. 40. SABINE.

	1″— 40″				1″— 32″		
R	3.10	2.80	3.40	2.60	3.50	3.20	3.41
P	——	14.6	15.0	15.25	14.75	13.6	13.7
	3.10				3.37		
	14.9				13.9		

1″— 50″

3.60	3.55	2.80	3.60	3.10	
14.5	14.5	15.25	15.0	15.25	

3.35
14.9

During reaction; *R* is slightly inhibited toward the end. There is no change in *V* except a very slight fall after the initial and final signals. *O* reported that he thought of the illusion during the normal. Notice the inhibited breathing and suppressed respiratory oscillations during the last 20″ of the normal. The rates of *R* and *P* are slowed and quickened respectively. This change, however, is opposed to that of the reaction.

EXP. 41. SABINE.

	1″— 40″				1″— 42″			
R	2.90	3.00	3.05	3.05	3.50	3.20	3.05	3.37
P	——	——	14.0	14.5	14.0	14.25	13.75	14.1
	3.00				3.28			
	14.2				14.0			

1″— 55″

3.50	2.10	3.05	2.25	2.35	4.00
14.2	15.2	15.0	15.0	15.5	14.0

2.87
14.8

During reaction: *R* is markedly inhibited (after three initial normal respirations). The respiratory oscillation is suppressed. *V* remains constant.

EXP. 42. MISS JENKINS.

	1″— 34″				1″— 44·5″				
R	3·00	2·45	3·05	2·75	3·50	4·00	3·95	3·70	4·00
P	12·5	12·0	12·0	12·5	12·5	13·5	13·0	12·5	12·5
		2.81					3.83		
		12.2					12.8		

1″— 49·5″

3·70	3·60	3·90	3·80	3·41
12·0	12·5	12·0	12·0	12·3

3.68
12.1

During reaction: *R* is somewhat inhibited. *V* is constant except for a slight fall after the signals at the beginning and end of the reaction. *O* reports that during recovery she tried to imagine what the illusion was; she was, therefore, attentive. This fact may account for the fast rate of *R* in recovery.

EXP. 43. MISS JENKINS.

[A control record was taken between exps. 42 and 43 to discover whether *O* was reacting normally. The slow normal rate of *R* in exp. 42 was unusual. The results show that normal *R* in exp. 42 is too slow—2.81 against 3.39 in the control record. The rate of pulse is practically the same—12.2 against 12.1 in the control.]

	1″— 40″				1— 39″			
R	3·70	3·90	3·20	3·30	3·65	3·85	3·90	3·61
P	12·5	12·7	12·0	11·5	11·25	12·25	12·5	11·9
		3·47					3·75	
		12·1					11·97	

1″— 58″

3·90	3·50	3·60	3·30	3·75	3·50
11·6	12·0	12·0	12·3	13·5	11·8

3·70
11·94

During reaction: *R* is slightly inhibited at first and afterwards becomes normal. There are no *V* changes.

Summary of Results.

Attention to radii of circle with intrinsic interest is characterized by:

i. Unequivocally increased rate of *R* (6 out of 7 cases). In 1 case *R* is unequivocally slowed.

ii. Unequivocally decreased rate of *P* (3 out of 7 cases). Unequivocally increased rate of *P* (2 out of 7 cases). In 2 instances, the rate of *P* of reaction is less than normal, and in 1 case the same as that of recovery: in the other case, more than rate of recovery.

iii. Inhibited breathing in every case; but usually not marked.

iv. Fall in volume only after signals.

5. The fixation and after-image experiments were reproduced with intrinsic interest. *O* was required to mark the periodicity of the after-image.

EXP. 44. SABINE.

1″— 40″

R	2.95	3.03	3.05	3.40
P	12.5	12.5	12.5	12.0

3.11
12.3

1″— 33″				1″— 47″				1″— 10″
3.35	3.25	3.33 :	3.25	3.10	2.95	3.00	2.85	3.05
12.0	12.25	12.3 :	12.75	12.0	13.0	13.0	12.5	12.5
		3.31	3.17	3.03				3.05
		12.1	12.4	12.6				12.5

During reaction: *R* is not inhibited during fixation; but is markedly inhibited during after-image. There is a fall in *V* after each signal.

EXP. 45. SABINE.

1″—40″				1″—20″		1″—21″	
R 3.05	3.30	2.95	2.95	3.45	3.22 :	3.40	2.95
P 12.0	12.0	12.0	11.75	12.0	12.0 :	12.0	11.75
	3.08				3.33	3.25	3.17
	11.93				12.0	11.93	11.87

1″—52″

3.45	3.00	3.25	3.30	2.85
12.75	14.0	13.0	12.5	11.8

3.17
12.8

During reaction: in fixation the height of *R* is not much changed; during after-image *R* is markedly inhibited. *V* is slightly less during reaction.

EXP. 46. SABINE

1″—38″				1″—20″		1″—19″	
R 3.75	3.45	3.55	3.75	3.50	3.40 :	3.25	3.38
P 12.75	12.0	12.25	13.4	12.0	13.75 :	11.75	12.1
	3.62				3.45	3.37	3.29
	12.6				12.4	12.1	11.9

1″—48″

3.05	3.30	3.50	3.20	3.00
12.0	12.25	12.0	12.0	11.5

3.21
11.9

During reaction: in fixation *R* is normal; but inhibited during after-image—more at the beginning than at the end. *V* falls sharply after the first and last signals; it is lower during after-image than during fixation phase. There is a sharp rise in *V* in the middle of fixation.

EXP. 47. MISS JENKINS.

	1″—41″				1″—21″			1″—23″		
R	2.90	3.25	3.30	3.63	3.70	4.00	: 4.00	4.00	3.75	
P	11.75	12.25	12.25	13.1	13.25	12.25	: 12.25	12.6	12.2	
	3.27				3.85		3.81	3.91		
	12.3				12.75		12.54	12.34		

1″—40″

4.50	4.00	3.90	3.60
12.25	12.25	12.3	12.0

4.00
12.2

During reaction: R is normal for fixation; but is inhibited for after-image. There are no V changes in this and the three following experiments because the plethysmograph functioned as a sphygmograph. Respiratory oscillations are suppressed throughout reaction, but more during after-image than during fixation.

EXP. 48. MISS JENKINS.

	1″—41″				1″—22″			1″—22″	
R	3.60	3.25	3.85	4.36	4.00	3.81	: 3.80	3.90	
P	12.8	12.25	12.75	12.9	12.0	12.0	: 12.0	12.0	
	3.76				3.90		3.87	3.85	
	12.6				12.0		12.0	12.0	

1″—46″

4.00	3.95	3.95	3.30	4.00
12.1	12.75	13.0	12.75	12.5

3.84
12.6

During reaction: R is somewhat inhibited during whole of reaction; but more during after-image than fixation. The respiratory oscillation is slightly suppressed.

EXP. 49. BAIRD.

1″— 37″

R	2.55	2.50	2.50	2.78
P	12.5	12.5	12.75	12.5

2.58
12.56

1″— 30″			1′—29″			1″—30″		
2.25	2.50	2.50 :	2.60	2.50	2.22	1.85	2.25	2.55
12.55	12.56	12.55 :	12.55	12.0	11.4	12.0	11.4	11.2
	2.41	2.42	2.44				2.21	
	12.57	12.21	11.85				11.53	

During reaction: the result of this curve is inconclusive, as the rates show a gradual falling-off throughout the experiment. There is no apparent change in depth of breathing.

EXP. 50. BAIRD.

	1″—37″				1″— 20″		1″—18″	
R	2.20	2.60	2.40	2.43	2.55	3.00	: 2.75	2.50
P	12.5	12.75	12.6	12.5	13.0	12.6	: 12.0	11.25
	2.40				2.77	2.70	2.60	
	12.5				12.8	12.2	11.6	

1″— 55″

2.75	2.00	2.00	2.25	2.40
11.8	11.8	11.6	11.8	11.6

2.28
11.7

During reaction: R is inhibited throughout; but much more during after-image than fixation.

Summary of Results.

Attention to fixation and after-image, with intrinsic interest, is characterized by:

i. Unequivocally increased rate of R (4 out of 7 cases). In 1 case R is slower than normal but greater than recovery. In 2 cases greater than normal but less than recovery. In 5 out of 7 cases, the fixation rate is greater than the after-image rate; in 2 out of 7, slower (only slightly).

ii. Unequivocally increased rate of P (1 out of 7 cases). Unequivocally decreased rate of P in 1 out of 7 cases. In 1 case P is unchanged. In 2 out of 7 cases P is faster than normal, but less than recovery. In 2 out of 7 cases P is slower than normal, but faster than recovery. The pulse changes in rate with respect to normal and recovery are inconclusive. But with reference to the fixation and after-image rates of P, the fixation rate is faster than the after-image rate in 5 out of 7 cases, one case unchanged, one case slower.

iii. Inhibited breathing. There is more inhibition during after-image than during fixation (6 out of 7 cases). 1 case is unchanged.

iv. Very slight fall in V.

These results, compared with the results without intrinsic interest, yield the following points of agreement and disagreement.

They agree in

i. Increased rate of R and the division of increase (6 cases each) between fixation and after-image phases.

ii. Inconclusive reaction of P; but rate of P in fixation is greater than the after-image.

iii. Inhibited R.

iv. Slight fall in arm volume.

They differ in that

i. Without intrinsic interest, R is inhibited more in fixation; while with intrinsic interest, the after-image phase is the more inhibited.

ii. With intrinsic interest, R is increased more in fixation than during after-image.

6. Stimulus: Questions in Philosophy.

The following six experiments were made with a view to

comparing the physiological reactions of attention with natural interest with the attentional reactions in which other interests are involved. (See above, Exp. 37.)

EXP. 51. SABINE.

Question: Arrange in order of birth a list of six philosophers (Leibnitz, Spinoza, Locke, Hume, Kant, Descartes). *O* was required to signal when the question was satisfactorily answered.

	1″— 40″				1″— 41″			
R	3·75	3·25	3·35	2·65	3·10	3·60	3·20	2·90
P	13·0	13·25	13·1	12·5	12·0	12·25	12·5	12·7
	3·25				3·20			
	12·96				12·37			

1″— 48″

3·05	3·05	2·75	3·5	3·25
——	——	13·0	13·75	13·4

3·12
13·0

During reaction: *R* is inhibited more during the middle of reaction than at the beginning or end. The plethysmograph functioned as a sphygmograph during this and the next three experiments. *O* reports that he had expected an easy question; he was surprised by the names, and at first somewhat confused. Attention became more intense toward the end of the reaction. During the recovery he thought of the series again.

EXP. 52. SABINE.

Question: The relation of mind to body in Descartes' system.

	1″— 40″				1″— 44″				
R	3·40	3·20	2·70	2·60	3·05	3·25	3·05	3·40	3·00
P	11·75	11·25	12·25	12·5	12·75	12·6	12·0	12·1	11·7
	2·97				3·15				
	11·9				12·23				

1″— 48″

3·60	3·40	3·25	3·25	3·37
12·6	12·3	12·1	12·1	——

3·37
12·27

During reaction: *R* is inhibited. *O* reports curiosity as to what the question would be. He had difficulty in thinking himself into Descartes' system. He attended to the question in an indistinct sort of way during the recovery.

EXP. 53. MISS JENKINS.

Question: Same as in last experiment.

	1″— 46″					1″— 39″			
R	3·25	3·05	3·40	3·55	4·00	4·50	4·25	3·75	4·38
P	13·75	14·75	13·5	13·5	12·9	13·2	13·3	12·9	13·1
		3·45					4·22		
		13·6					13·1		

1″— 27″

4.05 4.00 3.50
13.0 13.4 12.8

3.85
13.0

During reaction: *R* is inhibited.

EXP. 54. MISS JENKINS.

Question: Malthus' doctrine of population and food supply.

	1″—37″				1″—37″			
R	4.00	3.90	3.25	2.14	3.90	4.00	3.75	3.57
P	13.5	——	13.5	14.0	13.1	13.0	13.1	12.8

3.32
13.6

3.80
13.0

1″—50″

3.75 2.95 3.00 3.05 3.10
13.2 13.6 12.5 12.5 12.6

3.17
12.8

During reaction: *R* is inhibited, but more during the first half than in the last. The inhibition continues for 14″ in the recovery.

EXP. 55. BAIRD.

Question: Arrange names of philosophers, as in Exp. 51.

	1″—55″						1″—20″	
R	2.80	2.60	2.20	2.75	2.70	2.80	2.50	2.90
P	11.9	11.4	11.4	11.7	11.5	11.8	11.7	11.7

2.64
11.6

2.70
11.7

1″—58″

2.95 2.70 2.30 2.55 2.50 2.70
—— 11.6 11.5 11.4 11.0 11.1

2.61
11.3

During reaction: *R* is decidedly inhibited. *V* sinks greatly. *O* reports that the question was easy.

EXP. 56. BAIRD.

Question: Relation of mind to body in Descartes' philosophy.

	1″—36″				1″—38″			
R	3.00	2.50	2.45	2.60	3.00	2.50	2.75	2.50
P	11.9	11.5	11.9	12.0	11.9	11.7	11.2	11.2

2.63
11.8

2.68
11.5

1″—55″

2.90 2.45 2.40 2.30 2.50 3.00
11.3 11.1 10.5 10.8 10.6 11.0

2.59
10.9

During reaction: *R* is inhibited and *V* falls very decidedly. *O* re-

ports that there was a slight unpleasantness during recovery, since he could not get his mind off the subject.

Summary of Results.

Attention with natural interest is characterized by:

i. Unequivocally increased rate of R (4 out of 6 cases).

In 1 case rate of reaction R is less than normal and greater than recovery. In 1 case rate of R is greater than normal and less than recovery. Both reactions are from the same O.

ii. Unequivocally faster P (1 out of 6 cases).

Unequivocally slower P (1 out of 6 cases).

In 1 case P is faster than normal, and less than recovery.

In 3 cases P is greater than recovery, and less than normal.

iii. Inhibited breathing in every case.

iv. Fall in V in each of the two cases in which the plethysmograph functions properly.

II. Attention to Auditory Stimuli.

1. Stimulus: Difference tone. Attention was directed to a difference tone produced by Quincke's tubes, g^3–b^3. The tone was very prominent. O signalled when the difference tone was heard.

EXP. 57. GALLOWAY.

	1″—53″						1″—17″	
R	3.20	3.30	3.00	3.30	3.25	3.33	2.95	3.28
P	——	——	14.3	14.2	14.0	14.0	14.0	15.0
			3.26				3.11	
			14.1				14.5	

1″—60″

3.70	3.75	3.55	3.75	3.75	3.40	
14.5	14.7	13.5	14.0	13.5	14.0	
		3.65				
		14.0				

During reaction: R is not much inhibited. V first rises slightly, then falls decidedly. O reports a feeling of strain and a tendency to hold the breath.

EXP. 58. SABINE.

	1″—25″			1″—7.5
R	3.70	3.25	3.80	4.00
P	15.8	16.2	15.6	15.6
		3.58		4.00
		15.8		15.6

1″—70.5″

3.80	3.70	3.30	4.00	3.90	3.75	3.30	
15.8	16.6	14.8	15.0	15.9	16.1	15.2	
			3.68				
			15.6				

During reaction: *R* is greatly inhibited, but the respiratory oscillation is not much suppressed. *V* falls, reaching a minimum after the end of the reaction; and then returns rather slowly to normal.

EXP. 59. MISS JENKINS.

	1″—36″				1″—6″		1″—29″		
R	3.55	3.80	4.75	4.91	4.83		4.50	4.55	4.20
P	——	15.3	15.5	15.0	14.8		14.8	15.2	14.3
		4.25			4.83			4.41	
		15.2			14.8			14.7	

During reaction: *R* is slightly inhibited. *V* tends to fall; it reaches a minimum after the reaction.

EXP. 60. BAIRD.

	1″—40″				1″—10.5″	
R	2.30	2.40	2.20	2.75	2.85	2.38
P	15.4	14.7	15.2	15.4	14.4	14.6
		2.41			2.85	
		15.1			14.4	

	1″—41.5″			1″—9″	1″—20″	
	2.55	2.96	2.68	2.00	2.20	2.10
	14.7	14.6	14.9	15.0	13.9	13.8
		2.64		2.00	2.15	
		14.7		15.0	13.8	

During reaction: *R* is inhibited. *V* falls in both reactions, and attains a minimum after the reaction.

EXP. 61. BAIRD.

	1″—30″			1″—6″		1″—37″			1″—7.5″	1″—8.5″
R	2.85	2.35	2.45	2.25	2.00	2.45	2.50	2.64	2.53	2.52
P	10.9	11.0	11.4	11.0	11:0	10.9	10.5	10.5	11.3	10.5
		2.55		2.25		2.39			2.53	2.52
		11.1		11.0		10.7			11.3	10.5

During reaction: *R* very slightly inhibited. There is no appreciable change in *V*. *O* reports low degree of attention.

EXP. 62. GALLOWAY.

	1″—39″				1″—14″		1″—20″	
R	3.75	3.25	3.75	3.83	3.60	4.00	4.40	4.05
P	15.6	13.7	14.8	14.0	14.2	14.7	14.4	14.5
		3.64			3.80		4.22	
		14.5			14.45		14.45	

During reaction: *R* is slightly inhibited at the end of the reaction. There is no definite change in *V*. *O* reports that he was confused because one of the pipes at first failed to sound. He was not comfortable because the room was too cold.

Summary of Results.

Attention to difference tone is characterized by:

i. Unequivocal increase in rate of *R* (4 out of 8 cases). Unequivocal decrease in rate of *R*. 3 out of 8 cases.

In 1 case the rate of R is faster than recovery, but less than that of normal.

ii. Unequivocal increase in rate of P (3 out of 8 cases). Unequivocal decrease in rate of P (1 out of 8 cases). In 2 cases the rate of P is faster than recovery, but less than normal. In 2 cases the rate of P is the same as recovery, but less than normal.

iii. Inhibited respiration in every case, although in some cases only slightly.

iv. Fall in V in 5 out of 8 cases. In 2 cases V is unchanged; in one case it rises, falls, and rises again.

It may be questioned whether it was advisable to attempt two reactions during the same experiment, as was done in Exps. 61 and 62. The second reaction in both experiments has changes opposite to those of the first reaction. However, there is precedent for the procedure in Zoneff and Meumann's work.

2. Stimulus: Watch-tick receding and coming in. O signalled when the watch ceased to be audible and when it again became audible.

Exp. 63. Galloway.

	1″—45″					1″—12″	
R	3.60	2.90	3.10	3.10	3.00	2.45	
P	14.1	——	14.2	14.9	14.4	15.0	
			3.04			2.45	
			14.1			15.0	

1″—73″

3.75	3.60	3.50	3.65	3.75	3.40	2.75	3.00
15.5	14.5	14.9	14.7	14.2	14.2	13.6	14.0

3.42
14.4

During reaction: R is greatly inhibited; indeed almost suppressed. V falls greatly at the beginning of the reaction, and remains low for 25 after the reaction.

Exp. 64. Sabine.

	1″—40″				1″—15″		
R	4.00	3.45	3.25	3.90	4.10	3.80	4.00
P	15.1	14.7	15.2	15.9	15.0	16.2	15.6
		3.65				3.96	
		15.2				15.6	

1″—72″

4.30	4.00	3.90	3.90	4.00	3.30	3.75	
16.6	15.9	15.2	15.0	15.5	14.6	——	

3.88
15.4

During reaction: R is greatly inhibited; in fact, almost completely suppressed. V falls moderately and soon rises to normal.

EXP. 65. BAIRD.

	1″—40″				1″—41″			
R	2.90	2.65	2.20	2.85	2.65	2.75	2.55	2.50
P	12.6	12.6	12.0	12.1	11.9	12.5	12.3	12.5
	2.65				2.61			
	12.4				12.3			

1″—48″

2.50	2.65	2.55	2.60	2.43	
12.5	12.0	12.0	11.9	11.6	
		2.54			
		12.0			

During reaction: *R* is greatly inhibited. *V* falls decidedly.

EXP. 66. BAIRD.

	1″—40″				1″—36.5″			
R	2.70	2.20	2.75	2.75	3.00	2.75	2.50	2.23
P	——	12.7	13.2	12.4	11.8	11.8	11.9	11.2
	2.60				2.62			
	12.7				11.6			

1″—55.5″

2.71	2.35	2.20	2.10	2.25	2.50	
12.0	12.1	11.4	11.4	11.8	11.8	
		2.35				
		11.7				

During reaction: *R* is markedly inhibited, although more at the beginning than at the end. The respiratory oscillation is suppressed. *V* falls slowly, and reaches a minimum after the end of the reaction.

EXP. 67. GALLOWAY.

	1″—37″				1″—12″			
R	2.90	2.55	2.60	2.85	3.70	3.50	2.50	
P	15.7	16.6	16.3	16.7	15.2	16.0	14.5	
	2.72				3.23			
	16.3				15.2			

1″—82″

3.65	3.25	3.20	3.25	2.75	3.00	2.75	2.66	
16.5	16.5	16.2	16.2	15.6	16.0	15.7	15.3	
			3.06					
			16.0					

During reaction: *R* is greatly inhibited. *V* falls sharply, reaching a minimum at the middle of the reaction.

EXP. 68. SABINE.

	1″—48″					1″—28″		
R	2.90	3.05	3.60	3.40	3.75	3.75	3.25	3.50
P	13.7	13.2	13.4	13.7	14.1	12.9	11.3	11.0
		3.34				3.50		
		13.6				11.7		

1″—50″

3.25	3.20	3.10	3.00	3.40
13.7	13.6	12.6	12.5	12.4

3.19
12.9

During reaction: *R* is decidedly inhibited. *V* falls very slightly during the first half of the reaction, rising during the second half. The reaction is followed by several very deep *R*; *V* falls at this place.

EXP. 69. MISS JENKINS.

	1″—34″			1″—18″		1″—50″				
R	4.20	4.80	5.25	5.65	5.00	5.35	5.30	5.00	5.25	5.05
P	13.0	13.8	15.7	13.9	13.2	15.0	14.4	——	——	13.6

4.75	5.32	5.19
14.1	13.5	14.3

During reaction: *R* is inhibited progressively as the watch moved out, reaching a minimum at the limen. *V*, which had been low during the normal, rises markedly.

Summary of Results.

Attention to watch-tick receding and coming in is characterized by:

i. Unequivocally increased rate of *R* (5 out of 7 cases). Unequivocally decreased rate of *R* (1 out of 7 cases).

In 1 out of 4 cases *R* is greater than recovery but less than normal.

ii. Unequivocally decreased rate of *P* (4 out of 7 cases). Unequivocally increased rate of *P* (2 out of 7 cases).

In 1 case *P* is less than normal but more than recovery.

iii. Very great inhibition of *R*.

iv. Very marked fall in *V*, in 6 out of 7 cases; in one case, Exp. 69, there is a rise in *V*.

3. Stimulus: Watch-tick coming in and receding. *O* signalled when the watch became audible and when it ceased to be audible.

EXP. 70. SABINE.

	1″—35″				1″—22″			
R	4.00	3.60	3.40	3.80	3.20	3.20	3.80	3.50
P	14.9	14.8	15.5	15.4	14.2	13.4	13.4	13.6

3.70	3.42
15.1	13.6

1″—68″

4.00	4.00	4.10	3.90	3.55	3.90	3.43
14.7	15.1	14.8	14.9	14.2	13.8	13.8

3.84
14.4

During reaction: *R* is almost completely suppressed. There is a slight deepening in *R* at the moment when the sound is distinctly

audible, between the coming in and the going out of the stimulus. *V* falls gradually, reaching a minimum about the middle of the reaction; it begins to return to the normal before the end of the reaction.

EXP. 71. BAIRD.

1″—64.5″

R	2.35	2.35	2.30	2.30	2.45	2.40	2.00
P	12.8	12.5	12.6	12.5	12.6	12.4	12.6

2.30
12.5

1″—37.5″				1″—22″	
2.10	2.50	2.50	1.46	2.00	1.91
12.5	12.3	12.5	11.7	11.2	11.6
2.14				1.95	
12.2				11.4	

During reaction: *R* is strongly inhibited. *V* is greatly diminished, attaining a minimum after the end of the reaction. Note that the rates of *R* in the reaction are least at the beginning and end, where the attention to the stimulus must have been greatest, because the stimulus at those points was weakest.

EXP. 72. GALLOWAY.

	1″—20″		1″—18″		1″—14″	
R	3.25	3 20	3.25	3.31	3.15	3.00
P	16.4	16.1	14.9	15.9	16.5	16.2
	3.22		3.28		3.07	
	16.2		15.1		16.3	

During reaction: *R* is almost completely suppressed; *V* falls precipitately. (G.'s reactions on this day were not good, as it was difficult to obtain a quiescent normal.)

EXP. 73. SABINE.

	1″—55″						1″—19″		
R	3.30	3.35	3.35	3.30	3.20	3.60	3.70	3.30	3.50
P	13.9	13.4	13.3	13.4	12.9	13.2	13.4	12.6	11.7
			3.36				3.16		
			13.3				12.5		

1″—53″

3.35	3.00	3.10	3.50	3.12
13.3	14.5	13.6	12.7	12.2

3.21
13.2

During reaction: *R* is markedly inhibited both during the coming in and the going out of the watch, with a deep inspiration between. *V* is slightly less.

EXP. 74. MISS JENKINS.

	1″—25″			1″—16″		1″—40″			
R	5.35	5.20	5.50	4.95	4.65	5.40	5.70	5.00	5.00
P	——	——	14.0	13.6	13.1	14.0	——	——	——
	5.35			4.77		5.27			
	14.0			13.3		14.0			

During reaction: *R* is uniformly inhibited. *V*, which had been low before the reaction, rises during the reaction; it falls again after the reaction.

Summary of Results.

Attention to watch-tick coming in and going out is characterized by:

i. Unequivocally increased rate of *R* (1 out of 5 cases). Unequivocally decreased rate of *R* (3 out of 5 cases).

In 1 case *R* is slower than normal, but faster than recovery.

ii. Unequivocally increased rate of *P* in no case. Unequivocally decreased rate of *P* (4 cases out of 5).

In 1 case *P* is slower than normal, but faster than recovery.

iii. Inhibited *R* in every case.

iv. Diminished *V* in every case but one, which gave a rise. Compared with the results of Exps. 63-70, there is one difference, *viz.*, that the rate of *R* is increased in the former experiments, but is decreased in these.

4. Stimulus: Fork *C* of 256 vibs. *O* was required to mark the moment at which the tone ceased to be audible.

EXP. 75. MISS JENKINS.

	1″—33″				1″—8″	1″—42.5″			
R	4.20	4.90	4.60	5.00	4.7	4.20	5.00	5.40	4.80
P	——	15.0	15.1	15.6	15.0	15.0	16.0	16.0	——
	4.67				4.7	5.02			
	15.2				15.0	15.6			

	1″—8″	1″—36.5″			
	5.00	4.76	4.20	4.35	4.10
	——	14.8	14.1	13.7	15.2
	5.00	4.35			
	——	14.4			

During reaction: *R* is inhibited for both reactions. *V* falls for the first reaction, attaining a maximum after the second signal. The stylus of the plethysmograph did not write during the second reaction.

EXP. 76. BAIRD.

	1″—46″					1″—12″	1″—25″		
R	2.80	2.85	2.65	2.60	3.00	2.33	2.60	2.65	2.60
P	13.5	13.5	13.6	13.4	14.0	12.9	13.0	13.0	13.0
	2.78					2.33	2.61		
	13.4					12.9	13.0		

	1″—14″		1″—34″		
	2.50	2.25	2.50	2.50	2.40
	12.6	12.25	12.6	12.5	12.5
	2.37		2.46		
	12.4		12.5		

During reaction: *R* is inhibited for both reactions. *V* falls sharply in both cases, and also after the second signal, which marked the close of the reaction.

EXP. 77. GALLOWAY.

	1″—35″				1″—16″		1″—24″		
R	4.30	4.10	4.00	4.00	4.00	3.33	4.45	4.50	4.10
P	15.5	16.2	16.4	16.4	16.6	16.1	16.8	17.0	16.7
	4.10				3.66		4.35		
	16.1				16.3		16.8		

During reaction: *R* is not inhibited at first; but becomes increasingly inhibited. *V* is not much changed; but tends to increase.

EXP. 78. SABINE.

	1″—40″				1″—15″		
R	3.75	3.60	3.65	3.95	3.90	4.00	3.50
P	——	17.0	17.0	17.5	16.6	16.0	15.0
	3.73				3.80		
	17.6				15.8		

1″—70″

3.90	3.90	3.50	2.75	3.30	3.75	3.30	
17.0	17.0	17.5	17.8	17.0	17.6	16.0	
			3.53				
			17.1				

During reaction: *R* is inhibited. The respiratory oscillation is suppressed. *V* falls slightly; but falls more sharply after the second signal at the end of the reaction.

EXP. 79. BAIRD.

	1″—43″				1″—13″
R	2.50	2.55	2.85	2.30	2.16
P	12.9	12.7	13.0	12.1	12.1
		2.55			2.16
		12.6			12.1

1″—70″

2.50	2.40	2.35	2.35	2.65	2.25	2.40	
12.7	12.4	13.0	13.0	12.8	12.7	12.0	
			2.41				
			12.5				

During reaction: *R* is markedly inhibited. *V* falls slowly, reaching a minimum after the second signal.

EXP. 80. BAIRD.

	1″—45″					1″—15″		
R	2.60	2.40	2.75	2.75	2.60	2.00	2.20	2.50
P	12.8	12.9	12.9	13.4	12.8	12.4	13.0	13.4
		2.62					2.23	
		12.9					12.9	

1″—39″

2.25	2.50	2.60	2.55
13.0	12.8	12.5	12.2
	2.47		
	12.6		

During reaction: *R* is greatly inhibited. *V* does not fall very much. *V* rises greatly in recovery.

EXP. 81. GALLOWAY.

	1″—39″				1″—14″		
R	3.10	3.15	3.00	3.33	3.60	3.40	1.00
P	——	14.1	14.4	14.5	15.4	15.0	13.7
		3.14				2.66	
		14.3				14.7	

1″—70″

3.40	3.70	3.70	3.50	3.55	3.00	3.05	
15.6	15.8	15.8	15.7	15.3	14.4	13.8	
			3.41				
			15.2				

During reaction: *R* is inhibited; much more at the end of the reaction than at the beginning. The rates of *R* and *P* show a progressive slowing; so that, although the average rate of *P* is greater than normal, the last rate is decidedly less. It would seem that the tone, when strong, had produced an acceleration of pulse and respiration; later, as the dying tone was attended to, a slowing of *P* and *R*. *V* falls moderately and slowly, attaining a minimum after the end of the reaction.

EXP. 82. GALLOWAY.

	1″—40″				1″—15″	
R	3.50	3.85	3.15	3.00	2.85	1.70
P	——	14.5	15.1	14.9	16.0	15.0
		3.10			2.27	
		14.8			15.5	

1″—70″

3.50	3.50	3.30	3.30	3.15	3.45	3.10	
15.5	15.7	16.0	15.4	15.5	14.5	15.0	
			3.32				
			15.3				

During reaction: *R* is again progressively inhibited. This progressive inhibition is characteristic of *G*'s curves, but not of those of the other *O*'s. *V* falls, and remains low for many seconds, rising only toward the end of the recovery.

Summary of Results.

Attention to dying tone is characterized by:

i. Unequivocally increased rate of *R* (2 out of 10 cases). Unequivocally decreased rate of *R* (7 out of 10 cases).

In 1 case *R* is faster than normal, but less than recovery.

ii. Unequivocally decreased rate of *P* (5 out of 10 cases). Unequivocally increased rate of *P* (1 out of 10 cases).

In 2 cases *P* is faster than normal, but less than recovery.

In 1 case *P* is the same as normal, but more than recovery.

In 1 case there was no record of *P* (Exp. 75).

In exps. 77, 81, 82, there is a noticeable tendency to slower *P*.

iii. Inhibited breathing. In general, more at the end of the reaction than at first.

iv. Fall in *V* in every case but one (Exp. 77).

Note that the same *O* gives the three cases of increased rate of *P*.

Note also that the three cases of increased rate of *R* in the summary are given by *two O*'s, Miss Jenkins and Sabine (Exps. 75 and 78).

5. Stimulus: Forks *C* of 256 and *C* of 256 vibs. The forks were slightly mistuned. *O* was required to count the number of beats.

EXP. 83. MISS JENKINS.

	1″—42″				1″—17″	
R	4.90	5.10	5.40	5.00	5.15	4.85
P	15.0	15.7	15.9	16.0	15.4	15.4
	5.10				5.00	
	15.6				15.4	

1″—46″

5.00	5.00	4.25	4.75	5.00	
14.8	15.0	15.0	15.5	15.0	
		4.80			
		15.0			

During reaction: *R* is somewhat inhibited. *V* falls very slightly after the beginning of the reaction, then rises. It falls again after the signal at the end of the reaction. *O* reports that she could not hear beats.

EXP. 84. BAIRD.

	1″—39.5″				1″—30″		
R	2.75	2.75	2.55	2.68	2.85	3.00	2.89
P	12.5	12.8	12.5	12.4	12.3	12.1	12.2
	2.68				2.91		
	12.5				12.2		

1″—55.5″

2.47	2.65	2.75	2.50	2.45	2.50	
12.1	12.3	12.2	12.1	11.9	11.8	
		2.55				
		12.0				

During reaction: *R* is inhibited more at the beginning than at end. *V* falls moderately. *O* reports that he heard the beats and started to count them, but that his signal distracted him, so that he lost count and gave up.

EXP. 85. GALLOWAY.

	1″—30″			1″—19.5″		
R	3.80	3.25	3.65	3.40	3.10	3.89
P	16.1	16.3	17.0	17.2	15.4	14.9
	3.56			3.46		
	16.4			15.8		

1″—75.5″

4.09	4.40	3.65	3.85	3.40	3.40	3.80	3.90	3.50	4.00
15.9	17.1	17.2	16.4	16.4	17.8	15.8	17.2	16.2	17.8
				3.79					
				16.7					

During reaction: *R* is progressively inhibited. *V* falls between the beginning and end of reaction, tending to rise toward the end. There is a fall in *V* after the second signal. During recovery *V* rises steadily until 25″ from the end; at that point it falls. *O* reports difficulty in getting hold of beats: that was unpleasant. During the last part of the recovery the arm-rest became very uncomfortable. The last 25″ of the recovery is divided into periods of 5″ each.

EXP. 86. SABINE.

	1″—44″					1″—22.5″		
R	3.30	3.00	3.50	3.50	3.00	3.80	3.85	3.63
P	16.0	16.0	16.0	16.5	16.7	15.6	15.2	15.0
	3.30					2.76		
	16.2					15.2		

1″—53.5″

3.23	3.40	3.15	3.40	4.49
16.1	16.7	15.8	16.2	15.8

3.53
15.9

During reaction: *R* is inhibited more during the first part of the reaction than the last. *V* falls deeply, attaining a minimum about the middle of the reaction. *O* reports that he misunderstood the directions, supposing that he was to hear a difference tone.

EXP. 87. BAIRD.

	1″—57″						1″—11″
R	2.40	2.30	2.50	2.35	2.65	2.57	2.09
P	10.3	9.8	10.4	10.2	10.8	10.5	10.1
			2.46				2.09
			10.3				10.1

1″—58″

2.40	2.35	2.20	2.15	2.05	1.85
10.0	10.0	9.8	9.6	9.4	9.1

2.16
9.6

During reaction: *R* is slightly inhibited at first; but is progressively suppressed. *V* at first rises, then falls considerably; the minimum is attained after the reaction.

EXP. 88. BAIRD.

	1″—63″							1″—21″		
R	2.20	2.25	2.20	2.50	2.00	2.00	2.00	2.25	2.20	2.45
P	10.0	10.1	9.7	10.2	10.1	10.0	10.0	10.0	10.1	9.5
			2.16					2.29		
			10.0					9.9		

1″—40″

1.95	2.10	1.90	1.75
10.5	10.7	10.2	9.2

1.92
10.1

During reaction: *R* is very greatly inhibited. *V* first rises, then falls precipitately.

EXP. 89. GALLOWAY.

1″—82″

R	3.20	3.00	3.30	3.00	3.30	3.70	3.25	3.25
P	14.5	13.9	——	14.7	14.8	14.9	14.2	14.1

3.25
14.4

1″—25″			1″—15	
3.25	2.70	3.50	3.25	2.90
14.3	——	——	——	13.4
	3.11		3.07	
	14.3		13.4	

During reaction: *R* is inhibited. *V* is diminished.

EXP. 90. SABINE.

	1″—50″					1″—13.5″
R	3.10	3.20	3.25	3.20	3.50	3.11
P	13.1	13.4	12.8	12.8	12.7	12.6
			3.25			3.11
			12.9			12.6

1″—73.5″

3.52	3.25	3.10	3.00	2.90	2.70	2.88
14.2	13.4	13.0	12.9	12.9	11.7	12.3

3.05
12.9

During reaction: *R* is markedly inhibited at the end of the reaction. *V* falls moderately; but falls more greatly and for a longer time after reaction. *O* reports that he heard no beats. (The wax was knocked from the flatted fork.)

Summary of Results.

Attention involved in counting beats is characterized by:

i. Unequivocally increased rate of *R* (2 out of 8 cases). Unequivocally decreased rate of *R* (2 out of 8 cases).

In 3 cases *R* is less than normal, and greater than recovery.

ii. Unequivocally increased rate of *P* in no case. Unequivocally decreased rate of *P* (4 out of 8 cases).

In 4 cases *P* is less than normal, and greater than recovery.

iii. Inhibited breathing.

iv. Diminished *V* of arm in every instance.

These experiments are not satisfactory, since their purpose was achieved in a few instances only. Once the *O* misunderstood the directions; again, the wax fell off from the fork; once the beats could not be heard; and once the *O* lost count. But it seems worth while to publish them, even if they were not successful. The failure is always indicated, so that no one can be misled by the results.

III. Attention to Tactual Stimuli.

1. Stimulus: Cold Cylinder. A brass cylinder, cooled in

ice, was drawn over the skin on the inside of the arm, just above the elbow. *O* was asked to attend to the number, character and intensity of the cold sensations.

EXP. 91. MISS JENKINS.

	1″—31.5″			1″—29.5″		
R	3.65	4.00	4.08	4.38	3.15	3.33
P	12.0	12.4	12.6	11.7	12.2	10.8
	3.91			3.62		
	12.3			11.5		

1″—65″

3.90	3.50	4.00	3.65	4.00	4.00	4.00
11.7	11.6	12.0	12.8	12.4	11.6	11.8

3.86
11.9

During reaction: *R* is much more inhibited at first than later. *V* rises slightly, then falls.

EXP. 92. MISS JENKINS.

	1″—36″				1″—22″	
R	4.00	4.00	3.50	4.10	4.25	4.16
P	12.0	12.6	12.1	12.6	12.5	11.6
	3.90				4.20	
	12.3				12.0	

1″—66″

4.20	4.00	4.40	4.10	4.00	4.40	4.00
12.1	12.4	12.4	12.1	12.1	12.0	11.0

4.21
12.0

During reaction: *R* is irregularly inhibited. *V* falls slightly.

EXP. 93. BAIRD.

	1″—45″					1″—18.5″	
R	2.75	2.95	2.55	2.80	2.50	2.40	2.60
P	12.3	12.4	11.6	11.4	12.2	10.5	10.2
	2.71					2.50	
	11.9					10.3	

1″—50.5″

2.60	2.95	2.60	2.75	2.70	2.80	
12.0	12.2	12.0	12.0	12.3	12.1	

2.76
12.1

During reaction: *R* is greatly inhibited. *V* falls.

EXP. 94. BAIRD.

	1″—50″					1″—19″	
R	3.00	3.00	2.75	2.65	2.35	2.00	2.16
P	12.2	12.5	11.3	11.4	11.3	11.1	11.0
	2.75					2.08	
	11.7					11.0	

1″—53″

2.00 2.25 2.20 2.50 2.30
10.8 10.6 10.5 11.3 11.2

2.25
10.9

During reaction: *R* is greatly inhibited. *V* falls markedly. After the reaction there is a sudden fall in *V*. This fall may be due either to a noise in the hallway outside the room in which we were working, or to an after-image of the cold spots, which B. reported. The noise seems the more likely cause, as it was very loud and sudden.

EXP. 95. GALLOWAY.

	1″—44″					1″—17″	
R	3.50	3.25	3.30	3.00	2.87	2.25	3.14
P	16.0	15.7	16.0	16.0	15.7	13.7	13.3
	3.18					2.69	
	15.8					13.5	

1″—53″

3.50 3.40 3.60 3.00 3.69
15.0 15.5 15.5 14.5 15.3

3.48
15.1

During reaction: *R* is very greatly inhibited. *V* falls precipitately.

EXP. 96. GALLOWAY.

	1″—47″					1″—17″	
R	3.30	3.40	3.60	3.60	4.00	3.00	2.28
P	15.1	16.0	16.0	15.0	15.1	13.5	13.7
	3.58					2.64	
	15.4					13.6	

1″—58″

4.30 3.70 3.50 3.50 3.50 3.50
15.6 15.6 16.3 14.2 15.0 13.7

3.66
15.4

During reaction: *R* is greatly inhibited. *V* rises slightly (probably the crest of a vaso-motor wave); then falls greatly. Vaso-motor waves are noticeable in this curve.

EXP. 97. SABINE.

	1″—42″				1″—18″	
R	3.65	3.45	3.80	3.16	3.10	3.43
P	15.0	15.0	15.0	14.0	13.3	12.1
	3.51				3.26	
	14.7				12.7	

1″—65″

3.50 3.75 3.75 3.75 3.75 3.60 2.50
—— 13.6 14.3 13.9 14.3 13.8 14.0

3.50
13.9

During reaction: *R* is somewhat inhibited. *V* falls sharply and deeply.

EXP. 98. MISS JENKINS.

	1″—42.5″				1″—16.5″		1″—64″			
R	4.00	3.90	3.50	3.88	3.61	4.20	4.00	3.70	3.70	3.70
P	13.1	12.9	13.8	13.8	11.6	12.3	12.6	12.3	12.5	12.4
		3.82				3.90			3.77	
		13.3				11.9			12.4	

During reaction: *R* is inhibited. *V* falls slightly. *O* reports that the cylinders did not seem cold.

Summary of Results.

Attention to cold spots is characterized by:

i. Unequivocally decreased rate of *R* (6 out of 8 cases). Unequivocally increased rate of *R* (1 case out of 8).

In 1 case *R* is faster than normal, but less than recovery.

ii. Unequivocally decreased rate of *P* in 6 out of 8 cases. Unequivocally increased rate of *P* in 1 case.

In 1 case *P* is the same as recovery, but less than normal.

iii. Inhibited breathing in every instance. For some *O*'s. This change is great, while for others it is less.

iv. Fall in *V* in every case. But the amount and the suddenness of the fall vary with the *O*.

2. Stimulus: von Frey's Pressure Hair. The hair was adjusted to give liminal pressures.

EXP. 99. BAIRD.

	1″—42″				1″—16″	
R	3.25	3.00	3.10	2.90	2.05	2.50
P	13.7	13.4	12.4	12.3	11.2	11.3
		3.06			2.27	
		12.9			11.2	

1″—64″

2.50	2.55	2.75	2.55	2.60	2.53	
12.3	11.5	11.5	11.7	11.1	11.6	
		2.47				
		11.6				

During reaction: *R* is greatly inhibited throughout, but more at the end of the reaction. *V* is unchanged during the first half of the reaction; it rises sharply during the second half.

EXP. 100. GALLOWAY.

	1″—42″				1″—15″	
R	3.75	3.40	3.80	3.33	2.10	3.10
P	15.8	16.3	16.0	16.0	13.6	13.8
		3.57			2.60	
		16.0			13.7	

1″—66″

3.50	3.50	3.40	3.25	3.55	3.70	3.75	
13.5	14.7	15.1	15.2	15.2	15.2	15.0	
			3.52				
			14.8				

During reaction: *R* is decidedly inhibited. *V* falls markedly.

EXP. 101. SABINE.

	1″—61″						1″—12″
R	3.40	2.70	2.80	2.75	3.25	3.40	3.54
P	14.0	13.6	13.9	13.4	13.4	14.3	14.0
			3.05				3.54
			13.7				14.0

1″—50″

4.00	3.55	3.45	3.70	3.25	
15.0	14.8	13.6	13.6	13.6	
		3.60			
		14.1			

During reaction: *R* is inhibited. *V* falls.

EXP. 102. MISS JENKINS.

	1″—44.5″					1″—13.5″
R	4.25	4.25	4.25	4.50	4.44	4.00
P	13.2	12.9	12.7	12.6	13.7	11.5
			4.34			4.00
			13.0			11.3

1″—65″

4.19	4.00	3.50	3.75	3.50	4.00	
12.0	13.1	12.6	11.5	11.9	12.0	
		3.82				
		12.2				

During reaction: *R* is moderately inhibited. *V* falls slightly.

Summary of Results.

Attention to minimal pressure is characterized by:

i. Unequivocally slower *R* (2 out of 4 cases). Unequivocally faster *R* in no case.

In 1 case *R* is less than normal, but more than recovery.

In 1 case *R* is more than normal, but less than recovery.

ii. Unequivocally slower *P* (3 out of 4 cases).

In 1 case *P* is faster than normal, and slightly less than recovery.

iii. Inhibited breathing in every case; in 2 cases more than in the others.

iv. Fall in *V* in 3 instances; in 1 case *V* rises during part of the reaction.

3. Stimulus: Glass Cylinders. A series of cylinders of different sizes were pressed upon the arm of *O*, who was asked to judge which was largest and which smallest.

EXP. 103. BAIRD.

	1″—43″				1″—9″
R	2.75	2.60	2.60	2.58	2.33
P	13.5	12.9	12.9	13.6	12.2
			2.63		2.33
			13.2		12.2

1″—70″

2.70	2.90	2.75	2.75	2.90	2.60	2.75
13.0	12.6	12.2	12.5	12.9	12.7	12.6

2.72
12.5

During reaction: *R* is inhibited. In this and the following experiment there are no changes in *V*. The plethysmograph functioned as a sphymograph.

EXP. 104. BAIRD.

	1″—40″				1″—13.5″
R	2.25	2.85	2.50	2.75	2.55
P	11.9	11.5	11.7	12.1	11.4
	2.60				2.55
	11.6				11.4

1″—70.5″

2.85	2.50	2.40	3.00	2.40	2.25	2.35
12.1	11.7	11.9	12.2	11.9	11.6	11.4

2.53
11.8

During reaction: *R* is somewhat inhibited.

EXP. 105. SABINE.

	1″—30.5″			1″—14″		1″—36″	
R	3.00	2.75	2.85	3.57	3.33	3.30	3.15	3.60
P	12.8	12.2	11.4	11.2	13.4	12.6	11.8	12.0
	2.83			3.57		3.34		
	12.1			11.2		12.4		

During reaction: *R* is inhibited, more at the beginning than at the end of the reaction. *V* falls, reaching a minimum after the second signal.

Summary of Results.

Attention to size of cylinders is characterized by:

i. Unequivocally decreased rate of *R* (1 out of 3 instances). In 1 instance *R* is less than normal, but more than recovery. In 1 instance *R* is unequivocally increased.

ii. Unequivocally decreased rate of *P* in every case.

iii. Inhibited *R* in every case.

iv. Fall in *V* in the one experiment where it is recorded.

IV. Attention to Ideas.

1. Problems in mental arithmetic. The problem was given to the *O* verbally. When he had given his answer, *E* marked the point on the drum.

EXP. 106. GALLOWAY. 25 x 33.

	1″—38″				1″—39.5″		
R	3.45	3.00	3.10	3.00	2.65	3.50	2.70
P	15.0	14.3	14.3	14.3	15.8	16.3	15.6
	3.13				2.95		
	14.5				15.9		

1″—57.5″

3.00 3.15 2.95 2.75 3.00 3.21
15.0 14.5 14.7 14.0 13.8 13.7

3.01
14.3

During reaction: *R* is slightly inhibited. *V* is scarcely changed, although it is probably slightly lowered. *O* reports that he was a little flustered by the problem. He multiplied 33 by 25, which was harder than 25 by 33. Attention seemed to be divided among a mass of things.

EXP. 107. GALLOWAY. 42 x 19.

	1″—38.5″				1″—25″		
R	3.75	3.50	3.20	3.50	2.90.	2.95	2.40
P	15.7	14.5	13.6	13.5	14.2	15.3	14.8
	3.50				2.75		
	14.3				14.8		

1″—63.5″

3.19 3.40 3.30 3.20 3.45 3.15
14.1 14.7 14.1 14.4 14.7 14.2

3.28
14.3

During reaction: *R* is inhibited. There is not much change in *V*. *O* reports a distinct feeling of holding himself in check; higher degree of concentration than before. Did not get to work quite so quickly as before; but knew just what to do when he did get to work. Some numbers were running through his mind. One of them happened to be 19.

EXP. 108. SABINE. 37 x 19.

	1″—40″				1″—16″	
R	3.25	3.00	3.00	2.95	3.10	3.16
P	15.6	14.6	14.7	13.3	13.5	13.3
	3.05				3.13	
	14.5				13.4	

1″—66″

3.25 3.00 3.15 2.85 3.00 3.25 3.33
14.0 12.9 13.0 13.0 13.0 13.5 13.0

3.12
13.2

During reaction: *R* is inhibited. The respiratory oscillation is suppressed. *V* falls. *O* reports that the numbers at first staggered him, as they were larger than he expected; although the easiness of the operation became evident when he multiplied them. He did not visualize the numbers; probably talked them.

EXP. 109. SABINE. 78 x 27.

	1″—40″					1″—63″					
R	3.75	3.65	3.40	3.45	2.66	3.80	3.60	3.00	3.00	3.60	3.27
P	——	14.5	14.3	14.4	14.3	14.1	13.7	14.3	14.2	13.9	12.3
		3.38					3.38				
		14.3					12.7				

1″—11″

3.18
12.6

3.18
12.6

During reaction: *R* is inhibited, with a couple of outbreaks of deep breathing. *V* falls, then rises to maximum; falls during recovery. *O* reports that he made several starts; got nervous and flurried. He multiplied 78 first by 7 and then by 2; but when he came to add the products together, he had forgotten them. He had to begin over again. He did this three times. The nervousness was unpleasant, but the achievement pleasant.

EXP. 110. MISS JENKINS. 16 x 17.

	1″—43″				1″—19.5″	
R	4.30	4.00	3.75	4.00	4.25	4.73
P	15.0	14.4	13.9	14.0	13.6	14.8
	4.01				4.49	
	14.3				14.2	

1″—57.5″

4.28	4.15	4.25	3.90	3.90	3.92
14.0	13.7	13.7	13.4	13.2	12.8

4.06
13.4

During reaction: *R* is considerably inhibited. *V* falls; then tends to rise. It falls again after the end of reaction, and remains low to the end of the experiment. *O* reports that she was dismayed by the numbers, and made two or three attempts before succeeding. She tried to visualize them, but could not do it; she then tried to say the numbers; she thinks she may have made some movements in her throat, but was not conscious of any.

EXP. 111. BAIRD. 36 x 23.

	1″—21″		1″—12⅓″	1″—58⅔″					
R	2.50	2.36	2.48	2.50	2.70	2.70	2.35	2.50	2.70
P	——	10.4	11.0	10.8	10.4	10.8	10.1	10.5	10.5
	2.43		2.48	2.57					
	10.4		11.0	10.5					

During reaction: *R* is inhibited. *V* rises rapidly at first; then falls slightly to the end of the reaction. *O* reports that the degree of attention was not high; he visualized the figures as if they were on a sheet of paper. He did not succeed in adding the two products the first time. The second time he visualized the numbers perfectly. The visualization continued into the recovery.

EXP. 112. BAIRD. 97 x 59.

	1″—43⅓″				1″—19⅓″	
R	2.60	2.65	2.65	2.20	2.83	2.90
P	11.0	11.4	10.9	11.1	12.0	13.6
	2.50				2.86	
	11.1				12.8	

1″—58⅓″

3.00	2.60	2.85	2.90	2.70	2.50
13.0	11.9	11.6	11.9	10.4	9.5

2.76
11.4

During reaction: R is inhibited. V rises. There is a slight dip in the curve after the second signal. V falls during recovery. O reports that he visualized as before; he multiplied 97 by 60, then subtracted 97. No muscular tension.

Summary of Results.

Attention to ideas (multiplication) is characterized by:

i. Unequivocally increased rate of R (3 out of 7 cases). Unequivocally decreased rate of R (2 out of 7 cases).

In 1 case R is the same as normal, but faster than recovery.

In 1 case R is faster than the normal, but less than recovery.

ii. Unequivocally increased rate of P (4 out of 7 cases).

In 3 instances P is less than normal, but faster than recovery.

iii. Inhibited R in every case.

iv. Slight changes in V; in two instances there is a rise in V (Exps. 112 and 113); in 4 cases a fall.

In 1 case V is constant.

V. Attitude Experiments.

Stimulus: König fork A_3. The following experiments were devised with a view to showing whether it is possible to obtain from the same O characteristically different reactions to the same stimulus. It seemed possible to take three different attitudes to the same stimulus. These attitudes were described to O, who was afterwards required to assume in three successive experiments: (i) an attitude of indifference to the stimulus, both as regards affection and attention; (ii) an attitude of active attention; O was asked to make a judgment as to the place of the tone in the tonal scale; (iii) an attitude of affection exclusively; O was asked to give himself up to the pleasantness or unpleasantness of the experience.

EXP. 113. BAIRD. INDIFFERENT ATTITUDE.

	1″—43″					1″—27″				
R	2.45	2.50	2.50	2.50		2.50	2.00	2.20	2.00	2.10
P	10.9	10.4	10.6	11.1		11.2	10.0	11.0	11.0	11.7
		2.48						2.20		
		10.7						11.0		

1″—55″

2.50	2.30	2.40	2.35	2.40
11.1	10.9	10.6	11.2	11.0

2.48
10.9

During reaction: R is not inhibited. V rises during reaction. O reports that he did not know what to do. He began to introspect, to see whether he was behaving indifferently. He did not attend either to the pitch of the tone or to the affection.

EXP. 114. BAIRD. ACTIVE ATTITUDE.

	1″—47″					1″—12.5″	
R	2.40	2.30	2.60	2.30	2.50	2.00	2.00
P	11.1	10.8	10.7	10.6	10.7	10.6	10.4
			2.42			2.00	
			10.8			10.5	

1″—65″

2.09	2.20	2.20	2.25	2.40	2.10	2.00
10.3	10.2	10.4	10.4	10.5	9.8	9.8

2.17
10.2

During reaction: *R* is slightly inhibited. *V* falls markedly. There is a sudden dip in the curve after the second signal. *O* reports that he was all at sea. He imaged the *c* of the great octave as a standard; he knew that the stimulus fork was above that.

EXP. 115. BAIRD. AFFECTIVE ATTITUDE.

	1″—53″					1″—16″		
R	2.20	2.60	2.35	2.65	2.30	2.00	2.00	2.50
P	10.7	10.1	10.2	11.0	10.3	10.4	9.8	10.3
			2.42				2.15	
			10.4				10.1	

1″—54″

2.20	2.20	1.16	2.20	2.25
9.9	10.3	10.0	10.2	10.2

2.19
10.1

During reaction: *R* is plainly inhibited. *V* falls slowly, then rises sharply. *O* reports that he had trouble in finding any affective tone. He compared the affective tone of the stimulus with that of the imaged *c* of the great octave. He thought that the stimulus fork would be pleasanter if lower. About one-third from the end of the reaction the pleasantness began to appeal to him.

EXP. 116. BENTLEY. INDIFFERENT ATTITUDE.

	1″—49″					1″—27″		
R	3.20	3.50	3.15	3.05	2.85	3.00	2.90	2.75
P	13.5	13.4	13.9	13.5	13.4	13.5	13.6	13.5
			3.15				2.88	
			13.5				13.5	

1″—54″

3.25	3.25	3.20	3.20	2.73
13.5	13.8	13.9	13.6	13.3

3.12
13.6

During reaction: *R* is not inhibited. *V* is slightly less. *O* reports: Passive at first; became a little excited by the thought of responsibility; this was unpleasant. After three or four seconds settled down. When tone tailed off felt some strain, but it was not at all intense. Attention was not constant.

EXP. 117. BENTLEY. ACTIVE ATTITUDE.

	1″—45″					1″—21⅓″	
R	3.10	3.55	3.25	3.50	3.40	3.30	3.27
P	14.5	14.0	14.2	14.3	14.4	14.3	14.6
	3.36					3.28	
	14.2					14.4	

1″—58⅔″

3.20	3.10	3.50	3.55	3.40	3.12	
14.5	14.7	14.0	14.0	13.6	13.0	
		3.31				
		13.9				

During reaction: *R* is perhaps slightly inhibited. *V* does not change. *O* reports that he tried to get hold of some means of placing the tone; but was kept on edge. He decided that it was *C* above middle *C*. Got to reflecting on previous tone; the association was persistent; could not relax in recovery; kept thinking of the difficulty in placing the fork; got to ruminating, and so got off from the experiment.

EXP. 118. BENTLEY. AFFECTIVE ATTITUDE.

	1″—47″					1″—15″	
R	3.40	3.50	3.80	3.20	3.28	3.40	3.00
P	——	14.7	14.2	14.5	15.0	13.9	14.0
	3.43					3.20	
	14.6					13.9	

1″—61″

3.50	3.15	3.25	3.00	3.70	3.50
14.3	14.4	14.1	14.0	13.3	13.5
		3.45			
		13.9			

During reaction: *R* is slightly inhibited. *V* is not markedly changed. *O* reports a little inclination to compel enjoyment; said to himself 'that's a mellow, pleasing tone.' Pleasantness was weak, without much glow: dull, vague. Attention was directed to the smooth, sweet side of the tone.

EXP. 119. SABINE. INDIFFERENT ATTITUDE.

	1″—31″				1″—5″
R	3.25	3.10	3.25	2.95	3.30
P	13.9	13.1	13.0	13.3	12.8
	3.16				3.30
	13.3				12.8

1″—81″

3.60	3.50	3.30	2.70	3.40	3.00	3.30	3.18	
12.7	13.3	13.1	14.0	13.6	12.7	13.3	13.2	
			3.24					
			13.2					

During reaction: *R* is inhibited and continues inhibited for ten seconds after the reaction. *V* begins to fall during the reaction, attaining a minimum after the end of the reaction. *O* reports curiosity just as the tone began to sound; wanted to know whether it was high or low. Thought it was a pleasant tone; realized that he had signalled too soon; felt foolish.

EXP. 120. SABINE. INDIFFERENT ATTITUDE. *O* was asked to make the reaction longer than in the last experiment.

	1″—51″					1″—5″
R	3.75	3.00	3.00	3.00	3.55	3.30
P	13.3	12.7	13.2	13.0	13.1	12.0
			3.26			3.30
			13.0			12.0

1″—66″

3.40	3.10	3.00	3.00	2.75	3.20	3.30
12.8	12.7	12.8	12.7	11.6	12.0	12.3
			3.11			
			12.4			

During reaction: *R* is noticeably inhibited. *V* falls sharply, attaining a minimum after the close of the reaction. *O* reports no effort to attend; tone rather pleasant; attention was divided between the idea of signalling too soon and the tone itself. Not able to keep the pleasantness out. More pleasant than before.

EXP. 121. SABINE. ACTIVE ATTITUDE.

	1″—61″						1″—9″
R	3.40	3.45	3.20	3.00	3.30	3.20	2.55
P	12.0	12.7	12.5	12.7	13.0	13.2	13.1
			3.26				2.55
			12.6				13.1

1″—55″

3.00	——	——	——	——	——
12.0	12.1	12.6	12.3	12.0	12.2
		3.00			
		12.2			

During reaction: one respiration is less than normal, one is more. *R* is inhibited before the reaction. *V* falls. *O* reports: Reaction very unsatisfactory because of confusion. Attention was distracted by click of signal; tried to run through the scale for ground of comparison; asked himself, "How does this experiment differ from the last one?" There was a feeling of activity; consciousness of work to do; consciousness of movements in the throat.

EXP. 122. SABINE. AFFECTIVE ATTITUDE.

	1″—53.5″						1″—10.5″
R	3.20	3.10	3.40	3.25	3.00	3.00	2.90
P	12.7	11.6	12.3	12.6	11.8	12.0	11.4
			3.12				2.90
			12.2				11.4

1″—65″

3.30	3.20	3.05	3.00	3.35	3.05	2.10
12.6	12.1	10.5	11.0	11.7	11.5	12.8
			3.00			
			11.7			

During reaction: *R* is inhibited a little. *V* falls sharply in the second half of the reaction. There is a fortuitous fall in *V* 30″ after the reaction. It coincides with the very slow pulse (10.5). *O* reports tone not nearly so pleasant as he thought it was; as he listened, the

pleasantness became flat and dull; disappointed; unpleasant at the end.

EXP. 123. GALLOWAY. INDIFFERENT ATTITUDE.

	1″—42.5″				1″—13″
R	3.50	3.50	3.25	3.40	2.73
P	16.1	14.7	15.5	15.1	15.0
	3.41				2.73
	15.3				15.0

1″—70.5″

3.33	3.25	3.25	3.50	3.75	3.75	3.57
15.6	15.7	15.0	15.1	15.1	15.0	14.8

3.48
15.2

During reaction: *R* is inhibited. *V* rises, then falls, remaining low until after the reaction. *O* reports that the normal was unpleasant on account of discomfort in the hand. The tone washed out the unpleasantness, and a feeling of tension took its place. The tension was localized in the head and neck. There was a tendency to lean forward. Attitude was not passive or indifferent.

EXP. 124. GALLOWAY. ACTIVE ATTITUDE.

	1″—51.5″					1″—18.5″	
R	3.60	3.80	3.80	3.75	3.43	2.61	3.25
P	15.7	16.5	16.1	15.6	14.6	14.2	17.0
	3.67					2.93	
	15.7					15.6	

1″—59″

3.70	3.50	3.50	3.15	3.55	3.33
16.9	16.2	15.4	15.7	14.6	15.3

3.45
15.7

During reaction: *R* is inhibited. *V* falls, reaching a minimum after the end of the reaction. *O* reports a high degree of attention from the very first; there were strain sensations from the head and neck; there was also a strain in the throat as if he were trying to sing. He thought the tone was *G* or *A* below middle *C* for the male voice.

EXP. 125. GALLOWAY. AFFECTIVE ATTITUDE.

	1″—39.5″				1″—15.5″	
R	4.00	3.50	3.80	3.89	3.39	3.60
P	16.0	15.0	15.3	15.4	14.7	15.0
	3.79				3.48	
	15.4				14.8	

1″—74″

4.25	3.60	3.80	3.90	3.70	3.80	3.75
16.0	15.5	15.8	16.2	17.2	15.4	13.7

3.82
15.5

During reaction: *R* is inhibited. *V* falls moderately, not nearly so much as with active attention. *O* reports that he became expectant just before the reaction. The reaction began unpleasantly, because

the tone was not sounded intensively enough; it was hard to grasp. The affective tone then became slightly pleasant; then unpleasant, because the tone seemed rough. As a whole the experience verged on unpleasantness.

Summary of Results.

I. INDIFFERENT ATTITUDE.

i. *R* is unequivocally increased in 2 cases (same *O*).
R is unequivocally decreased in 3 cases.

ii. *P* is unequivocally increased in 1 case.
P is unequivocally decreased in 3 cases.
P is same as normal, but less than recovery, in 1 case.

iii. *R* is not inhibited in 2 cases; in 3 cases it is inhibited.

iv. *V* rises in 1 case; rises and falls in another; in the other three cases, falls either slightly or much.

II. ACTIVE ATTITUDE.

i. *R* is unequivocally slowed in every case.

ii. *P* is unequivocally quickened in 2 cases.
P is unequivocally slowed in 1 case.
P is greater than recovery, and less than normal, in 1 case.

iii. *R* is inhibited slightly in 2 cases, in 1 case irregularly inhibited; in the fourth case more greatly inhibited.

iv. *V* falls in 3 cases; in one case it is unchanged.

III. AFFECTIVE ATTITUDE.

i. *R* is unequivocally slowed in every case.

ii. *P* is unequivocally slowed in 2 cases.
P is equal to recovery, but less than normal, in 2 cases.

iii. *R* is inhibited in every case, but only slightly in 2 cases.

iv. *V* in one case falls and rises; in one case remains unchanged and then rises; in 1 case shows no change; in the last instance falls.

Summary of the same Results, according to Observers.

I. INDIFFERENT ATTITUDE.

BAIRD	R —	P +	R inhibited	V +
BENTLEY	R —	P=K	R inhibited	V — (very slightly)
SABINE (i)	R +	P —	R inhibited	V —
SABINE (ii)	R +	P —	R inhibited	V —
GALLOWAY	R —	P —	R inhibited	V + —

II. ACTIVE ATTITUDE.

BAIRD	R —	P —	R inhibited	V —
BENTLEY	R —	P +	R inhibited slightly	V = K
SABINE	R —	P +	R irregularly inhib.	V —
GALLOWAY	R —	P +	R inhibited	V —

III. AFFECTIVE ATTITUDE.

BAIRD	R —	P —	R inhibited	V —

BENTLEY	R —	P —	R inhibited slightly V = K
SABINE	R —	P —	R inhibited slightly V —
GALLOWAY	R —	P —	R inhibited V —

VI. Miscellaneous Experiments.

Two sorts of experiments fall under this head: (i) aborted experiments, in which, for any reason, the required conditions were not fulfilled; and (ii) three experiments in which it was attempted to secure a state of active attention without resorting to sensory stimulation. Expectation on the part of *O* was the chief cause of the first class of experiments. If, during or about the end of the normal period of quiescence, *E* saw the *V*-curve suddenly fall, it was usually safe to conclude that the *O* was strongly expecting the stimulus. Only one such experiment occurred in the visual, while there were several in the auditory experiments.

EXP. 126. MISS ANDRUS. Stimulus should have been a Masson disc.

1″—97″

R	3.00	2.90	3.00	3.00	2.95	3.00	2.75	2.60	3.10	3.42
P	12.0	11.5	11.7	11.2	11.5	11.0	11.2	11.0	11.5	11.4

2.97
11.4

1″—30″

2.25	2.85	2.60	2.70
10.5	11.0	11.5	11.0

2.60
11.0

Up to 80 seconds the rate of *R* is fairly constant. After that point the rate is noticeably increased. There is a less marked increase in the rate of *P*. The fall in *V* began earlier than the changes in the rate of *R* and *P*. At the 97th second, *E* said "there will be no stimulus this time." After that the rates of both *R* and *P* decrease. *V* begins to rise. *O* reports a definite expectation of the experiment some time before *E* said that there would be no experiment.

EXP. 127. GALLOWAY. Stimulus should have been watch-tick coming in and receding.

1″—87″

R	3.25	3.05	2.75	2.70	2.95	2.75	2.40	2.60	2.85
P	15.5	16.3	16.7	16.4	16.3	16.7	15.3	15.2	15.2

2.81
15.9

1″—42″

2.90	2.90	2.75	3.12
—	15.1	16.1	15.7

2.91
15.6

At the 40-50 second *E* saw the volume fall spontaneously, with inhibition of *R*. He suspected expectation and therefore did not give the stimulus. At the 87th second, *E* said 'no experiment;' *V* then

rises, and the rates of R and D tend to increase. The expectation seems to be characterized by a slowing of both P and R.

EXP. 128. GALLOWAY. Stimulus should have been the counting of beats.

1″—95″

R	3.75	3.25	2.95	3.45	3.55	3.25	3.75	3.20
P	13.8	14.4	—	14.4	14.1	14.5	14.2	14.6

3.39
14.2

1″—37″

3.50	3.05	3.00	2.93
14.6	15.0	14.0	13.5

3.12
14.2

At the 95th second E saw V fall and suspected expectation. He said 'no experiment.' After this, rates of both R and P tend to decrease, and V rises. O reports that he was perplexed by thinking how he should describe the beating tones.

EXP. 129. GALLOWAY.

Stimulus should have been the counting of beats. E gave the signal 'now;' but delayed some seconds to actuate the forks. As E thought too much time had been lost, he did not sound the forks at all, but after 21 seconds said 'no experiment.'

1″—53″					1″—21″	
R 3.25	3.20	3.10	3.20	3.26	3.30	3.54
P 16.1	15.6	15.3	15.1	15.0	15.5	15.4
3.20					3.42	
15.4					15.4	

1″—50″

3.50	3.40	3.20	3.10	3.25
15.4	14.7	15.0	15.8	14.6

3.29
15.1

For the reaction, the rate of R is unequivocally quickened. The rate of P is the same as the normal but greater than the recovery. This means an increased rate of P, because the initial normal rate of P is unusually high. R is inhibited a little; more at the end than at the beginning. V falls almost immediately, and begins to rise before the end of the reaction.

EXP. 130. GALLOWAY.

Stimulus should have been the counting of beats. The normal was so irregular that no stimulus was given. After 60 seconds, E said 'no experiment.'

1″—61″

R	3.80	3.40	3.40	3.50	3.00	3.13
P	16.0	15.0	——	14.2	14.0	15.2

3.37
14.8

1″—60″

4.05	3.50	3.00	3.45	3.30	3.00
15.0	15.2	15.0	15.0	14.7	——

3.38
14.9

In each half of this experiment, the rates of both R and P begin rather high and fall off during the rest of the experiment. O reports that his shoe pinched; that there was a feeling of relaxation after the signal 'no experiment.'

EXP. 131. BAIRD.

Stimulus was the slow tick of a metronome—39 per minute.

	1″—48⅓″					1″—30⅔″		
R	2.25	2.55	2.45	2.10	2.40	2.12	2.40	2.20
P	9.9	10.6	10.7	10.2	11.7	10.1	10.6	10.3
		2.35					2.24	
		10.6					10.3	

1″—47″

1.80	1.70	2.00	2.05	2.30	
10.0	9.7	9.8	9.8	10.0	
		1.97			
		9.8			

During reaction: R is considerably inhibited, more in the middle of the reaction than elsewhere. V falls sharply, reaching a low level. O reports a feeling of strain which he could not localize: it seemed as if the clicks were never going to come.

EXP. 132. SABINE.

Stimulus should have been a cold cylinder. E, seeing the volume fall and suspecting expectation, said 'no experiment.'

1″—50.5″

R	3.50	3.00	3.50	3.75	3.33
P	15.5	15.1	13.6	13.4	13.5
			3.40		
			14.0		

1″—70.5″

3.80	3.65	3.35	3.80	3.55	3.50	3.00
12.9	13.0	13.3	14.0	13.5	13.0	13.0
			3.52			
			13.2			

O reports: nothing prominent in consciousness; rather surprised when E said 'no experiment;' thought something had gone wrong. There is second spontaneous fall in V 30 seconds before the end of the curve.

E was probably wrong in attributing the first fall in V to expectation, inasmuch as O's introspection did not bear him out.

The three following experiments were devised with a view to securing a high degree of attention without direct stimulation of the sense organs. It seemed possible to attain a moderately high degree of attention by letting ideas, as in a revery, take their own course through consciousness. The experiment began with normal indifference on the part of O. As soon as he became interested in his ideas, he signalled; when his interest was interrupted, he signalled again; so that the period of the greatest clearness of ideas was marked off from the normal and recovery periods.

EXP. 133. BENTLEY.

1″—39″

R	2.80	3.20	3.05	3.44
P	14.0	13.6	13.6	13.5

3.12
13.7

1″—86″

2.95	2.90	3.10	3.05	3.05	3.00	3.05	3.30	3.00	
13.5	13.5	13.6	13.3	13.4	13.4	12.9	12.6	12.6	

3.04
13.2

During reaction: *R* is, if anything, a little higher; but the difference is very slight. *V* rises very gradually throughout the curve. *O* reports that during normal he was thinking 'Now I must get myself into this state;' there was more tension, more excitement than in reaction. During reaction attention went up and down; there was a high degree of attention because the ideas were clear; but attention was not constant. Also there was a conscientious pulling together now and then, along with a feeling of responsibility. There were excitement and unpleasantness with the sense of responsibility. Good bodily tone; quite relaxed.

EXP. 134. BENTLEY.

	1″—25″			1″—35″				1″—3″
R	2.80	3.10	3.40	2.50	2.75	2.75	2.70	4.00
P	13.4	13.5	12.8	13.4	13.4	12.6	13.4	12.6
		3.10				2.67		4.00
		13.2				13.2		12.6

1″—47″

3.00	3.25	2.80	2.80	2.85	
13.2	13.5	13.4	13.5	13.5	

3.11
13.4

1″—10″

3.00
13.5

3.00
13.5

During the first reaction, *V* is a little higher; there is a slight drop in the curve at the beginning of the second reaction. *O* reports that during normal he is getting adapted to the situation. During the first reaction, attention was flighty and there was some excitement. Unpleasantness because attention was spasmodic and fitful. A little bit disappointed with the state of things. During the second reaction, he picked his way through ideas. Attention if anything was unpleasant

EXP. 135. BENTLEY.

1″—16″

R	2.90	3.33	
P	13.5	12.6	

3.11
13.0

1″—110″

R	3.10	3.10	3.60	3.00	3.35	3.40	3.20	3.10	3.05	3.25	3.10
P	13.6	13.5	13.6	13.0	13.0	13.0	13.8	13.5	13.5	13.7	13.0

3.20
13.3

During reaction there is no noticeable change in the depth of *R*. *V* tends to rise gradually. *O* reports: normal free from affection; set-

tling down. Reaction. Attention to auditory ideas and visual perceptions. *O* made a false signal, which made him uncomfortable, because he thought it might confuse *E*. There was a strain of unpleasantness all through. An occasional idea with fleeting unpleasantness. Moderate degree of attention; not sharp.

Summary of Results of Last Three Experiments.

i. There is no consistent change in rates of *P* and *R*.

ii. Slightly increased *V* and slightly deeper breathing occur in revery.

iii. Probably sensory stimulation causes fall in *V*.

iv. Apparently centrally excited feelings have very slight effect on *P*, *R* and *V*.

EXP. 136. SABINE. *E* traced with a pencil the letters *H C S* on *O*'s cheek. *O* attempted to decipher them.

	1″—42″				1″—24″		
R	4.00	3.10	3.10	3.33	3.50	3.25	3.10
P	12.8	11.5	12.0	12.5	11.2	10.6	11.2
		3.38				3.28	
		12.2				11.0	

1″—58″

3.90	3.50	3.30	2.80	2.60	2.70
11.4	11.6	11.1	11.4	12.4	12.2

3.13
11.6

During reaction: *R* is considerably inhibited. *V* falls markedly, reaching a minimum after reaction.

C. GENERAL SURVEY OF RESULTS AND DISCUSSION.

I. Changes of Rates of P and R.

1. In order to put the main results of the study in form for discussion, the experimental data may now be tabulated. Since there were many equivocal results, either some rule must be adopted for their interpretation, or they must be excluded from the Table. But since these results may be instructive in themselves, it was not deemed proper to exclude them. There are six sorts of equivocal cases:

1. Reaction rates of *P* and *R* faster than normal and slower than recovery.

2. Reaction rates of *P* and *R* slower than normal and faster than recovery.

3. Reaction rates of *P* and *R* same as normal and faster than recovery.

4. Reaction rates of *P* and *R* same as normal and slower than recovery.

5. Reaction rates of *P* and *R* same as recovery and faster than normal.

6. Reaction rates of *P* and *R* same as recovery and slower than normal.

The following disposition was made of these cases. 1, 3, and 5 were counted with the unequivocal increases in the rate of *P* and *R;* cases 2, 4, 6, were counted with the unequivocal decreases in rate. Since there were four physiological symptoms determined, there will be four main rubrics in the Table: rate of pulse; rate of respiration; depth of respiration; and volume. Under each of these rubrics there will be three sub-heads, since each physiological symptom may vary in any one of three ways, *viz.*, *P* and *R*, with respect to rate, may increase, decrease, or remain unchanged; *R*, with respect to height, may increase, decrease, or remain unchanged; *V* may rise, fall, or remain unchanged. The experiments are grouped according to the sense department to which the stimulus appealed. Thus, there is a visual, auditory, and tactual group. The number of experiments is also given (Table I, p. 466).

The Table shows characteristic differences of reaction for the different kinds of experiments. For the visual group the rate of *R* is very greatly increased. The rate of *P*, on the other hand, does not change consistently. In approximately half the cases, the rate of *P* is faster, and in the other half, the rate is slower. The auditory group shows another correlation. The rate of *P* in these experiments is as decidedly decreased as the rate of *R* was increased in the visual group. The rate of *R*, on the other hand, in the auditory group is almost as equivocal as was the rate of *P* in the visual group. The tactual group varies in still another way. Both *R* and *P* are very decidedly slowed. The changes for multiplication resemble those for visual stimuli. This may be due to the fact that the *O*'s as a rule visualized the figures. The other physiological symptoms seem to show no differentiation according to stimulus. The overwhelming result for all experiments is inhibited breathing and diminution of the *V* of the arm. In order that the characteristic changes in rate of *P* and *R* may not be attributed to the manner of distribution of the equivocal results, the unequivocal results are given alone, in a similar Table (Table II, p. 467).

The Table of unequivocal results brings out the same fact as the Table of both equivocal and unequivocal results. In the visual experiments, the rate of *R* is always faster, while the rate of *P*, with the exception of the experiment with the Masson disc, is about evenly divided between faster and slower. In the second group, the rate of *P* is very decidedly slower, while the rate of *R* is in some cases faster and in others slower. The slowing of both *P* and *R*, in the third group, is even more pronounced than in the Table of mixed equivocal and unequivocal results.

TABLE I.

Kind of Experiment	PULSE			RESPIRATION						VOLUME			Number of Experiments
				RATE			DEPTH						
	Faster	Slower	Unchanged	Faster	Slower	Unchanged	Deeper	Shallower	Unchanged	Fall	Rise	Unchanged	
Masson disc	9	4	1	13	1			14		13	1		14
After-image	5	7		9	3		1	11		11	1		12
Radii of Circle	6	4		9	1		2	8		7		3	10
Radii with Intrinsic Interest	2	5		6	1			7		7			7
After-image with Intr. Interest	3	3	1	6	1			6	1	3		4	7
Natural Interest	2	4		5	1			6		2		4	6
Difference tone	3	5		4	4			8		5	1	2	8
Watch in-out-in	2	5		5	2			7		6	1		7
Watch out-in-out	0	5		1	4			5		4	1		5
End of Tone	4	5	1	3	7			10		9	1		10
Counting Beats	0	8		3	5			8		8			8
Cold Cylinder	1	7		2	6			8		8			8
Pressure Hair	1	3		1	3			4		3	1		4
Comparing Size of Cylinders	0	3		1	2			3		1		2	3
Multiplication	4	3		5	2			7		4	2	1	7

NOTE. In fifteen experiments, volume changes were not recorded because the plethysmograph functioned as a sphygmograph. These experiments were 19, 30, 37, 38, 39, 47, 48, 49, 50, 51, 52, 53, 54, 103, 104. The cause of this fact was a leak in the air system.

TABLE II.

Kind of Experiment	PULSE			RESPIRATION			No. of Experiments
	Faster	Slower	Unchanged	Faster	Slower	Unchanged	
Masson disc	8	2		10			14
After-image	3	2		8			12
Radii of Circle	2	3		8			10
Radii (Intrinsic Int.)	2	3		6	1		7
After-image (Intrinsic Int.)	1	1		4			7
Natural Interest	1	1		4			6
Difference tone	3	1		4	3		8
Watch out-in-out	2	4		5	1		7
Watch in-out-in	0	4		1	3		5
End of tone	1	5		2	7		10
Counting beats	0	4		3	2		8
Cold Cylinders	1	6		1	6		8
Pressure Hair	0	3		0	2		4
Size of Cylinder	0	3		1	1		3
Multiplication	4	0		3	2		7

The experimental results of this study force, then, the following conclusion upon us. Either we must say that active attention is different in kind according as the object of attention is a visual, auditory, or tactual sensation, in just the same way as we speak of visual and auditory types of memory; or we must say that the changes in the rates of P and R are not due to attention at all, but are due to the psychophysical process of the sensation; or, as a third possibility, to the co-operative influence of both attention and the psychophysical process of sensation. The first possibility may be correct, although at present there is no theory of attention which discusses such a view.[1] As for the third possibility, the method of expression has assumed that the purely reflex effect of the stimulus, if any at all, is very slight, compared with the expression of the mental process. There is, however, positive evidence in favor of the second possibility. Mentz[2] says, "With tones and clangs, as well as with noises, in consequence of increasing intensity, there appears an increasing lengthening of pulse which, nevertheless, with high intensities is again decreased on account of unavoidable unpleasantness, and indeed even passes over to a shortening. The cause of the original

[1] *Cf.*, however, Art. Attention in Baldwin's Dict., I, 86; also Titchener, *Am. Jour. of Psych.*, XVI, 214.
[2] Phil. Stud., XI, 95.

lengthening is probably a direct effect of the psychophysical process of the sensation, since this process physiologically spreads out more widely in the organism with greater intensities, and thus draws into sympathetic action not only the involuntary and voluntary muscles, but also the vessels and, with greater intensities the heart." Mentz gives results from Mosso's work which show the same effect of auditory stimuli. Lehmann[1] says with regard to the physiological effect of cold: "It follows that cold, in every case, produces a lengthening of pulse, except where it is painful; then it, like every other unpleasant stimulus, has as a consequence shortening of pulse." Warmth has the opposite physiological effect. Finally, Kelchner[2] finds that "with pleasantness the pulse is accelerated, if the pleasantness is set up by taste stimuli; the pulse is slowed if tones and colors serve as stimuli." In the case of unpleasantness, there was no differentiation of results according to stimulus. Changes in respiration were also independent of stimulus. While it is true that there is not a uniformity among these purely physiological effects, as one might expect if the reaction were reflex, it is quite possible that different intensities as well as different qualities of stimulus give different physiological reactions. The Ritter-Valli phenomenon is a case in point. With a certain very low intensity of stimulus, the extensor muscles of the claw of the crayfish are stimulated; with higher intensities, the flexors.[3] Something of this sort may hold for smooth muscle. Again, it is known that exposure to low temperature depresses the vaso-constrictor nerves more than the vaso-dilator nerves. Also, if a mixed nerve is stimulated with rapid induction shocks, the effect is vaso-constriction; if with slow induction shocks, vaso-dilatation. Assuming the results to be purely reflex, there seems to be sufficient evidence, on physiological grounds alone, to account for divergences.

It will probably be urged against this view that it takes account of only a few negative cases, while it neglects a well confirmed correlation, that between changes in rate of P and R and active attention. We propose, therefore, to examine the experimental evidence for this correlation. The results may be thrown into a Table (Table III) which will include the name of the investigator and the date of his work; the stimulus to attention and the resultant changes in rates of P and R, together with the number of experiments and the number of O's, so far as these data are obtainable. The plus and minus

[1] Die körp. Aeusser. psych. Zustände, 114.
[2] Arch. f. g. Psych., vol. V, 39.
[3] *V.* Schäfer's Physiol., II, 480, for a description of this and similar phenomena.

TABLE III.

Investigator		Stimulus to Active Attention	Pulse			Respiration			No. of Exprs	No. of O's
			Faster	Slower	Unchanged	Faster	Slower	Unchanged		
Mosso	1879 1881		+			No correlation				
Von Thanoffer	1879	Intellectual work (arithmetic)	+							
Gley	1881	Intellectual work (reading)	+							
Delabarre	1892	(i) Muscular effort: single pressure of dynam.; sustained pressure; pressed thumbs together; moved arms up and down.				+			not given	1
						+				1
		(ii) Auditory: metronome. For D.				+			"	1
		For R. when normal rate did not exceed 25				+			"	1
		For P. when normal rate was 26					—		"	1
		For P. when normal rate was 15.				+			"	1
		For Rn.				+ very slight			"	1
		(iii) Visual—Looking at objects. For D.				+			"	1
		Rivalry of Perception. Observer not given.				+			"	
		(iv) Tactual. Designs traced on skin For D.				+			"	1
		For R and Rn.				changes very slight			"	2
		(v) Counting objects. For D.				+			"	1
		(vi) Reading mentally. " "				+			"	1
		(vii) Writing. " "				+			"	1
		(viii) Internal recitation				Sometimes faster			"	
		" music if music is sad				—			"	
		if music is gay				Not so slow			"	
		(ix) Arithmetic. For D.				+			"	1
		For Rn.				+ a little			"	1
		For R.				Little changed			"	1
		(x) Recollection of series of letters. For D.				+			"	1
Mentz	1895	Metronome rates	+			+			20	3
		Comparison of two intervals filled with metronome beats	+						1	1
		Comparison of two pitches given by Appunn tonometer	+			1	2	1	4	1
		Multiplication	+			+			2	1
		Descartes' theory (i) without effort reproduced	+			+			2	1
		(ii) Exactly reproduced	+			+			1	1
		Watch at liminal distances	+			4	4		8	1
		Different degrees of attention to metronome beats	10	6		8	8		16	2
Binet and Courtier	1895	Arithmetical operations	+	— one O					not given	7
	1896	(i) Short intense work. Mental arithmetic	+			+			9	6
		(ii) Prolonged intellectual work		—					2	2
Shields	1895	"Mental reaction"	+							12
McDougall	1896	(i) Watch liminal	+			+			not given	7
		(ii) Tactual—Design traced on skin		—			—			5
		(iii) Recall of past events—Lecture, instruments, events in a day	±			+			"	5
		(iv) Arithmetical operations	±			+			"	5
Angell and Thompson	1899	Addition, memorizing nonsense syllables, multiplication	No correlation			No correlation			"	2
Lehmann	1899	Punktezahlen, multiplication, reading over nonsense sylables, recollection of melody	+			Irregular. Toward end of reaction faster.			"	not given

		down.				+			given	1
		(ii) Auditory: metronome.								
		For D.				+			"	1
		For R. when normal rate did not exceed 25				+			"	1
		For P. when normal rate was 26					—		"	1
		For P. when normal rate was 15.				+			"	1
		For Rn.				+ very slight			"	1
		(iii) Visual—Looking at objects. For D.				+			"	1
		Rivalry of Perception. Observer not given.				+			"	
		(iv) Tactual. Designs traced on skin For D.				+			"	1
		For R and Rn.				changes very slight			"	2
		(v) Counting objects. For D.				+			"	1
		(vi) Reading mentally. " "				+			"	1
		(vii) Writing. " "				+			"	1
		(viii) Internal recitation				Sometimes faster			"	
		" music if music is sad				—			"	
		if music is gay				Not so slow			"	
		(ix) Arithmetic. For D.				+			"	1
		For Rn.				+ a little			"	1
		For R.				Little changed			"	1
		(x) Recollection of series of letters. For D.				+			"	1
Mentz	1895	Metronome rates	+			+			20	3
		Comparison of two intervals filled with metronome beats	+						1	1
		Comparison of two pitches given by Appunn tonometer	+			1	2	1	4	1
		Multiplication	+			+			2	1
		Descartes' theory (i) without effort reproduced	+			+			2	1
		(ii) Exactly reproduced	+			+			1	1
		Watch at liminal distances	+			4	4		8	1
		Different degrees of attention to metronome beats	10	6		8	8		16	2
Binet and Courtier	1895	Arithmetical operations	+	— one O					not given	7
	1896	(i) Short intense work. Mental arithmetic	+			+			9	6
		(ii) Prolonged intellectual work		—					2	2
Shields	1895	"Mental reaction"	+							12
McDougall	1896	(i) Watch liminal	+			+			not	7
		(ii) Tactual—Design traced on skin		—			—		given	5
		(iii) Recall of past events—Lecture, instruments, events in a day	±			+			"	5
		(iv) Arithmetical operations	±			+			"	5
Angell and Thompson	1899	Addition, memorizing nonsense syllables, multiplication	No correlation			No correlation			"	2
Lehmann	1899	Punktezahlen, multiplication, reading over nonsense sylables, recollection of melody	+			Irregular. Toward end of reaction faster.			"	not given
Winkler	1898	Concentration of attention.	+			+				
Hirsch	1899	Mental arithmetic	+							
Zoneff and Meumann	1901	(i) Optical	3	16		14	5		19	5
		(ii) Acoustic		7		6	1		7	3
		(iii) Tactual		5		4	1		5	3
		(iv) Attention to ideas. Multiplication	3	7		7	3		10	4
Bonser	1903	Multiplication, memorizing, reading difficult books	During preliminary vaso-dilatation + Rate is not given for rest of reaction							12
Gley	1903	Questions involving natural interests	±			+				

signs mean acceleration and retardation of P and R. $\pm$ means acceleration followed by retardation.

TABLE III.

With regard to the rate of P, the Table shows uniformity, with three exceptions: (i) the slowing of P with tactual stimuli, in McDougall's experiments; (ii) the slowing of P in all of Zoneff and Meumann's experiments; (iii) the denial of correlation by Angell and Thompson. There is also the fact, first pointed out by McDougall, that frequently the rate of P first increases, then decreases even below the norm. Binet and Courtier confirm this result, as does Gley in his later work. Unfortunately, most investigators have given only the main results of their work. The total number of experiments, and especially the number and kind of discrepant results, are almost always lacking. The rate of R is uniformly increased, with three exceptions: (i) Mosso found no correlation; (ii) McDougall found slowing of R with tactual stimuli; (iii) Angell and Thompson deny correlation. And Lehmann found increase in rate of R only under certain conditions. On the other hand, Delabarre, Mentz, McDougall, Binet and Courtier, and Zoneff and Meumann find, on the whole, an increased rate of R, although had Delabarre taken more observations from other O's than 'D,' his results would, apparently, have been different. A fact which may possibly help to explain the universal quickening of R is the almost universal use of visual stimuli, such as reading, counting dots, arithmetical operations, which were probably performed visually, and reading-over nonsense syllables. Of course, against this suggestion, it can be shown that Mentz used auditory stimuli mainly and nevertheless found quickened rate of R, although there were many cases of retarded R, and that McDougall did not use visual stimuli at all. But on the other hand, Zoneff and Meumann make 19 experiments with optical stimuli against 12 with acoustic and tactual together. A reasonably long series of experiments with auditory and tactual stimuli has never been made. Whatever may be the cause, the present status of the matter is this: for pulse, (i) two contradictory correlations, (ii) a denial of correlation; for respiration, (i) a uniform correlation, (ii) a partial contradictory correlation, and (iii) two denials of correlation.

We think, therefore, that the appeal to the facts does not sustain the objection that we have based our thesis on a few irregularities in the face of a well established correlation. The well established correlation does not exist. And furthermore, what correlation there is depends on a narrow range of ex-

periments, in which discrepancies have been largely neglected, carried out on a small number of *O*'s.

Again, it may be objected that the discrepancies in our results can be explained by differences in the state of attention itself. It may be said that attention to minimal pressures and cold spots is not of the same sort as attention to a Masson disc. In the one case attention is powerfully attracted; in the other it has to be sustained by effort. In short, the tactual and part of the auditory experiments are expressions of passive attention, while the visual experiments are expressions of active attention. This theory of the results would bring about a happy compromise. According to it, the results would confirm Mentz' thesis that active attention accelerates *P* and *R*, while passive attention retards them. And so the question of the validity of the method would not be raised at all. This view has a certain amount of plausibility, but it leaves out of account several considerations. (i) The known physiological fact that stimulation of a centripetal nerve or of a sense organ does produce reflex acceleration or slowing of the heart. There is no uniform result (such is the impression one gets from Tigerstedt's review[1] of the literature) from this sort of stimulation; but the important point for this argument is, that the heart does respond reflexly. (ii) The purely physiological effects of certain stimuli, demonstrated by Mentz, Lehmann and Kelchner. (iii) The difficulty of discovering a reason for calling attention to tactual and auditory stimuli passive, and attention to visual stimuli active. Attention to a liminal pressure or auditory stimulus is, surely, just as active as attention to a liminal visual stimulus.

A third objection may be made: that we use the method of expression to obtain results, while we deny that the method is expressive. This objection is merely verbal. The method, apparently, is not expressive in that it consistently characterizes a total state which we call active attention; but it is expressive in the sense that it responds to certain physiological processes which may vary while the total state of attention, as regards degree and kind, remains the same. That is, the method is expressive for certain inessential features of the attentive experience; but it is not expressive for the state as a whole, which is itself the object of investigation.

The argument of this paper, up to this point, may now be summarized. The method of expression has failed in the domain of feelings. Two possible reasons were suggested: (i) complications with other mental processes, and (ii) the psychophysical processes of the sensation. The results of this

[1] Phys. des Kreislaufes, pp. 282-289, 1893.

study point definitely to the second factor, unless one is willing to speak of visual, auditory and tactual attentions, as we speak of visual or auditory memories. Three objections were brought against this view. (1) It is based on a few discrepancies from a well established correlation. Reply: the correlation is not well established. (2) The results are the expressions of active and passive attention. Reply: liminal stimuli all require active attention, yet the expression is different. (3) We deny that the method of expression is expressive, and yet make use of its results. Reply: this objection is merely verbal.

II. The Significance of the Changes in Volume. So far, we have considered only two symptoms of the expressive method, *viz.*, changes in rate of *P* and *R*. It may now be asked whether the changes in *V* and depth of breathing are expressive or merely reflex. In these experiments, as Table I. shows, *V* and depth of *R* changed consistently with active attention. Wherever there was a state of active attention, there were always a fall in *V* and inhibited breathing. These two symptoms, therefore, would seem to be the characteristics of active attention. But there is, at least, positive evidence against the *V* change. Just as the changes in rates of *P* and *R* brought suspicion on themselves by a too pliant response to experimental conditions, so the *V* change brings suspicion on itself by a too indiscriminate response to experimental conditions. The all but invariable reaction in our own experiments was a fall in *V*. The all but invariable reaction in the whole literature of the expressive method, whether applied to the feelings or to attention, is a fall in *V*. We conclude, therefore, that *every sensory stimulus tends to produce a fall in volume of the arm*. The evidence for this thesis is as follows. (i) In exps. 133, 134, 135 of this paper, in which there was a state of active attention without sensory stimulation, *V* showed no tendency to fall. (ii) The greatest and most sudden changes in *V* come at the very beginning of the reaction, during or immediately after the period of stimulation, although it is improbable that the highest degree of attention has been attained at that point. (iii) The fact, already mentioned, that fall in *V* independent of mental conditions has been the almost universal reaction in all experiments with the plethysmograph. A detailed review of the results of the method of expression as regards *V* will, we think, bear out this statement. The results may be tabulated. The name of the author, the date of his work, together with the kind of stimulus, affective or attentive, and the change in volume expressed by a plus or minus sign to indicate a rise or fall respectively are given.

The Table shows a uniform decrease in *V* for all mental con-

TABLE IV.

Investigation	Stimulus	Volume
Mosso 1879, 1881	Every psychic activity	—
Féré 1887	Pleasant	+
	Unpleasant	—
Lehmann 1892	Pleasant	+
	Unpleasant	—
Hallion and Comte 1894	Tactual, auditory pain	—
Shields 1895	Olfactory sensations and mental work	—
Binet and Henri 1895	Cold, tactual sensations	—
	Pleasant and unpleasant emotions	—
	Intellectual work	—
Binet and Courtier 1896	Pleasant and unpleasant emotions	—
Angell and McLennan 1896	Active attention	— 75%
		+ 25%
	Agreeable	+ ? %
	Disagreeable	— 90%
McDougall 1896	Watch tick, mental arith., recall of past events	—
Angell and Thompson 1899	Emotions, intellectual operations, sensations	—
Lehmann 1899	Voluntary attention	—
	Involuntary attention (fright)	—
	Spannung	—
	Unpleasantness	—
	Pleasantness	+
Gent 1903	Strain	—
	Relaxation	+
	Pleasantness	+
	Depression	—
Gley 1903	Mental arithmetic	—
Bonser 1903	Mental arithmetic	—

ditions, with the exception of Féré's, Lehmann's and Gent's work. Angell and McLennan found a rise in *V* with agreeable stimuli in an unspecified percentage of their experiments. But since they do not publish curves, or state their results precisely, one is justified in not taking their results into account.

We propose, now, to examine, so far as this is possible from their published results, the evidence for the rises in volume asserted by Féré, Lehmann and Gent. Féré, *Sensation et Mouvement*, finds that sensory stimuli when tested with a dynamometer fall into a dynamogenic series. In chapter XVII, he finds that taste, smell, auditory and visual stimuli, when tested with the plethysmograph, also arrange themselves according to the degree of their effects. Féré does not say, as he does in the case of the dynamometry experiments, that the change in *V* is correlated with the affective tone of the stimulus. On the contrary, at least in the case of diffusible excitants as alcohol and ether, he suggests that the type of reaction is due to intensity of stimulus. "Une excitation faible produit la dilatation; une peu plus forte, la dilatation suivie de rétraction proportionelle; une excitation très forte, une rétraction immédiate" (p. 108). On p. 113 Féré says, "Toutes les émotions dépressives déterminent une diminution de volume dans les membres; toutes les émotions excitantes ou agréables déterminent un effet inverse." We have failed to discover any curves in either edition of *Sensation et Mouvement* which exemplify this conclusion.

Lehmann, *Die Hauptgesetze* etc., publishes nineteen curves, of which thirteen are reactions to simple pleasant or unpleasant stimuli. The curves with the initial of the observer and stimulus are as follows:

I A.	M	Sugar solution.
I B.	C	Eau de Cologne.
I C.	M	Saccharin.
I D.	D	10% quinine sulphate.
II A.	D	Lukewarm water with a few drops of tartaric acid.
II B.	D	Hand in 50° water. Unpleas.
II C.	M	Pin stuck in nates.
II D.	M	Carbon bisulphid. Told it was pleasant.
II E.	O	Arm in water 43°. Decidedly pleasant.
III A.	D	Tobacco cigarette. Pleasant.
III B.	O	" " Unpleasant.
III C.	M	Wall paper. Æsthetic pleasure.
IV A.	D	Tuning fork sympathetically actuated. Intellectual pleasure.
IV B.	M	Fright.
IV C.	E	Fright.
IV D.	D	Depression.
V A.	E	Fear.
V B.	E	Fright.
V C.	M	Anger.

These experiments, where possible, were carried out on two other observers. In all there must have been fifty-seven curves, of which thirty-nine were simple feeling curves. But we are here concerned only with the curves of pleasantness. These curves are I A, I B, I C, II E, III A, III C, IV A. If these experiments were repeated on two other observers, there must have been twenty-one curves to generalize from. These curves must now be examined with regard to the amount and character of the rise in *V* and its coincidence with the period of stimulation.

I A. The V before stimulation is very low. Just after stimulation there is a sudden though very slight rise in V. The V remains almost level for thirty seconds, although there is a slight gradual increase, which reaches a maximum twenty-eight seconds after the stimulus was applied. The absolute and relative change in V is so slight and comes so long after the stimulus that it seems very doubtful whether any positive conclusion can be drawn from it.

I B. There is undoubtedly a rise in V coincident with the period of stimulation. Although it should be pointed out that the V was low when the stimulus was applied.

I C. This curve is very much like I A. The normal is very low and the reaction is very long delayed (due to the dissolving of the saccharin, Lehmann says) and very slight when it comes. About twenty-two seconds after the substance is tasted and forty seconds after it is administered, there is a slight rise in V.

II E affords a good illustration of the freedom of interpretation that is possible in work of this kind. Lehmann says that for ten seconds after stimulation the V diminished, then increased until it exceeded the normal level. So it does; but not until thirty seconds after stimulation. Without some good introspective reason, it seems inadmissible to call a subsequent rise in V, after an initial fall, the expression of an affective process.

III A. Lehmann calls this curve an *ausgeprägte Lustcurve*. The fact is this. The V for nearly thirty seconds after stimulation is less than that at the time of stimulation. A decided rise in V does not occur until forty-five seconds after stimulation. Furthermore, the rise in V does not occur so soon nor is it so marked when it occurs, as is the rise in V in III B, the unpleasant tobacco curve. In III B a very decided rise in V occurs a few seconds after the stimulus is applied. There is a low V for twenty seconds, with a very decided increase before the period of stimulation is over. This curve is very much like II E in its general type. The stimulus for II E was *entschieden lusterregend*. Lehmann finds a physiological reason for the fall in V in II E, although, apparently, he is willing to attribute the fall in volume in III B to the unpleasantness of the tobacco. If II E is called a curve of pleasantness, we see no reason why III B should not be so called.

III C is a curve of æsthetic pleasantness. The V falls for about ten seconds, then slowly attains and gradually surpasses the level before stimulation, and sinks slightly below the normal level before the stimulus is removed. Here, again, the curve has the same general aspect as II E, III A and III B, namely, a low level for several seconds after stimulation, with a gradual return to the normal level or above it. But there is a positive rise in this curve, coincident with the period of stimulation.

IV A. This curve is an example of intellectual pleasantness. The stimulus was the perception of a tuning fork actuated sympathetically by another fork. The V begins low, and had already begun to rise before the stimulus was applied. It continues to rise throughout the period of stimulation, reaching a maximum after the stimulus has ceased.

The result of this examination is that out of seven curves of pleasantness in only three is there an unequivocal rise in V coincident with the period of stimulation. And in each of these curves there is some questionable circumstance. In I B and IV A the V was low and had already begun to rise when the stimulus was applied. In III C, the rise in V follows a marked fall in V.

Lehmann gives fifteen examples of *Lustzustände* in the *Körp. Äuss.*

psych. Zustände. These experiments are described in the text, pp. 131-136. The list of curves, with the initials of the observer and the stimulus, is as follows.

1.	XLIII D.	P. L.	Smell of saffron.
2.	XLIII E.	P. L.	Nitrobenzol.
3.	XLIV A.	A. L.	Menthol.
4.	XLIV B.	A. L.	Chloral.
5.	XLIV C.	P. L.	Patchouli.
6.	XLIV D.	S. N.	Attar of roses.
7.	XLV A.	A. L.	Saffron.
8.	XLV B.	Dr. B.	Menthol.
9.	XLV C.	A. L.	A bit of sugar.
10.	XLV D.	P. L.	Powdered chocolate.
11.	XLVI A.	H. K.	Chocolate cake.
12.	XLVI B.	P. L.	Cheerful tune.
13.	XLVI C + D.	A. L.	Colored photograph.
14.	XLVI E.	A. L.	Spontaneous pleasant memory.
15.	XLVII A.	A. L.	Satisfaction at solution of easy problem.

No. 1. About nine seconds after the beginning of stimulation, the curve reaches its lowest level. It then rises sharply, reaching the normal level eighteen seconds after stimulation and finally exceeding the normal *niveau.*

No. 2. There is a slight rise in *V* just after stimulation, followed by a fall in *V*, which remains low. Lehmann does not call this a rise.

Nos. 3, 4, 5. Show short, sharp rises in *V* either in part coincident with the stimulus or entirely so (as in No. 5).

No. 6. There is a slight rise in *V* coincident with the stimulus. But one can hardly refrain from the thought that had the stimulus occurred a few seconds earlier, under a respiratory oscillation, the result would have been just as good.

No. 7. The *V* rises sharply out of the normal level coincident with the first half of the period of stimulation. It falls during the last half of the stimulation, reaching a lower level than the normal.

No. 8. A very decided fall in *V*, which Lehmann suggests may be due to the very long deep respiration and strain of attention.

No. 9. The stimulus is followed by a long, low fall in *V* which never exceeds the normal level.

No. 10. The stimulus is applied at the lowest point in the curve; the *V* gradually rises, reaching the normal level about eight seconds after the chocolate was tasted, and surpassing the norm.

No. 11. The stimulus is followed by a fall in *V*, which at no time afterwards exceeds the normal level.

No. 12. The *V* falls during half the time the melody was played; it rises during the other half. But it does not exceed the normal level at any time during the period of stimulation. Afterwards it rises considerably.

No 13. Closely resembles No. 12. The *V* is low during the whole period of stimulation; it rises, and remains continuously high, after the exposure of the picture.

No. 14. The *V* begins to rise with the first signal and rises steadily to an acme just above the second signal.

No. 15. The curve rises slightly after the first signal, falls, then begins to rise a little before the second signal. It does not reach a high level at any time.

The review shows that positive rises in *V* coincident with stimulation occur in curves 3, 4, 5, 6, 7, 10, and 14. That is, in seven out of fifteen cases. An examination of all the curves reveals three kinds of

rises in *V*. (i) An initial rise coincident with the period of stimulation. As in curves XLIV A, B, C, D, and XLV A. (ii) A rise when the normal *V* is very low, as in curves XLV D and E. (iii) A rise which follows a more or less prolonged fall in *V*. It seems possible to bring all of these curves, with the exception of XLV D and E, under one head. The general character of the curves is the same. There is a positive rise in *V* or, at least, a tendency to rise just after or along with the application of the stimulus. This initial rise is followed by a fall in *V*, after which the *V* regains the normal level or exceeds it. Instances of this general character are curves XLIII D and E, XLIV A, B, C, D, XL A, B, C (not D), XLVI A, B, C (not E) and XLVII A. All the curves, with two exceptions, conform to this general type. Of course, the three parts of the curve, the initial rise (or tendency to rise), the fall and the subsequent rise may vary considerably in different curves. For example, there is no tendency for the *V* to rise just after stimulation, in curves XLVI A, B and C. But the subsequent fall and rise is, apparently, a constant character of every curve mentioned. Now these two rises, the initial, and the final rise after the fall, permit great latitude of interpretation. If the initial rise is very slight, the expression of the pleasantness is looked for in the final rise, as was the case in XLIII D and XLVI B, C. On the other hand, if the initial rise is considerable, even if the final rise is large, the first rise is called the expression of pleasantness. Witness curves XLIV A, B, C, D, and XLV A. The fall in *V* and subsequent rise occur in these curves as in all the others; but the characteristic expression of the feeling is said to be the initial rise, which in these cases is large. This license in interpretation is responsible for much of the apparent success of the method. So long as the expression of the feeling may be looked for anywhere from 2 seconds to 1 minute, after the time of stimulation, without an exact introspective check on the interpretation of the curve, one must expect that arbitrariness of interpretation with which not only Lehmann but others after him may be justly charged. But, waiving that objection, the fact remains that there are seven positive rises in *V* coincident with the stimulus. This number is not sufficient to establish the correlation, even if those curves were unobjectionable. But it may be urged against them that in the best examples, XLIV A, B, C, and XLV A, the sudden rises occur where there is considerable disturbance of the breathing, due, probably, to the use of olfactory stimuli. And in one case, XLV D, the stimulus was applied when the *V* was very low.

Gent[1] describes four reactions of mixed pleasantness and strain, although only one curve is published. The curves with the initial of the *O* and the kind of stimulus are as follows:

1.	Ch.	Smell of fresh lemon.
2.	Ch.	Menthol.
3.	Ha.	Violet.
4.	Wi.	Violet. (Fig. 13.)

No. 1. We quote Gent's description of these curves, with the exception of the last. "In die Reizphase tritt die Volumcurve ansteigend ein mit wachsenden Pulshöhen und wird in ihrem Fortgange kaum von dem Geruchreiz alteriet. Sobald derselbe sein Ende erreicht hat, sinkt er plötzlich, so dass es den Eindruck macht, als sei der bisherige Hochstand des Niveaus nicht der normale gewesen" (p. 757).

No. 2. "Die Volumcurve tritt ansteigend ohne Spontanschwankungen und Respirations-oscillationen in die Reizphase ein" (p. 758).

[1] Philosophische Stud., XVIII, 757.

No. 3. "Das Beispiel bietet den allgemeinen Zügen nach dasselbe Verhalten dar, wie die bereits besprochenen Beispiele, nur dass hier das Armvolumen nicht ansteigend, sondern mit Neigung zur Senkung in die Reizphase eintritt" (p. 758).

No. 4. The *V* rises very slightly for three pulses, falls for six pulses and rises during the remainder of stimulation, reaching a maximum after stimulation. This curve has the same general character as those of Lehmann already discussed. There are an initial rise, fall, and final rise in *V*. It is an important matter for interpretation to know which of these phases is the essential reaction. Of these four curves there seems to be only one, No. 2, which shows an unequivocal rise in *V* coincident with the stimulus. The first curve is 'scarcely altered' by the smell stimulus. No. 3 yields a fall in *V*. No. 4 is half-rise and half-fall. Yet, on the basis of these experiments, Gent feels justified in concluding that: "Das Gefühl der Lust erzeugt immer ein Anschwellen des Armvolums mit Zunahme der Pulshöhen" (p. 759). Gent has also some *V* curves to show the effect of pleasant emotions. But he concludes that "das Armvolumen zeigt weder ein constantes Steigen noch Sinken" (p. 781).

Gent finds that the feeling of relaxation (*Lösung*) is characterized by a rise in *V*. He describes five experiments with that feeling, the stimulus to which, in every case, is a problem in multiplication. The characteristic reaction is a fall in *V*, while the problem is being solved (*Spannung*), followed by a rise in *V*, which may begin before the problem is solved, and which continues to rise above the normal level after the solution is reached. It is possible that this rise in *V*, after stimulation, is an active expression of the feeling of relaxation, as Gent holds. But it seems more likely that it is a purely passive restoration of physiological equilibrium which has been disturbed by the stimulus.[1] Only one curve (Fig. 8) is published, so that it is not possible to give a detailed criticism. But it seems unlikely that the satisfaction of performing a simple arithmetical operation should express itself by such a powerful and continuous rise in *V* as is shown in Fig. 8, while it is next to impossible, by any sort of pleasant sensory stimulation, to obtain even a very moderate rise in *V*.

We have now finished the review of those instances of rise in *V* on the basis of which a correlation with pleasantness has been established. Féré has published no curves with which we are acquainted, showing the effect of pleasant and unpleasant stimuli on *V*, although he is the author of the correlation. In Lehmann's first work there are three rises in *V* coincident with the stimulus; in his second work there are seven rises coincident with the stimulus. In Gent's curves, there is one rise in *V* coincident with the stimulus. Therefore, there are eleven rises in *V* coincident with a pleasant stimulus in the literature[2] of the expressive method.

This paucity of positive rises in *V* has not escaped other observers. Lehmann says, "It is a well known circumstance that the bodily ex-

[1] *Cf.* Zoneff and Meumann, Phil. Stud., XVIII, 63, for the similar view that after retardation of *P* by pleasantness, *P* tends to increase from purely physiological causes.

[2] Féré cites the results of L'herminier, Études plethysmographiques en psycho-physiologie, Thèse, Bordeaux, 1897, in support of his theory. I have not been able to consult this paper.

pressions of pleasurable states can be demonstrated only with great difficulty. While I found earlier (in the *Hauptgesetze*) that all simple pleasurable feelings are accompanied by increase in V, in addition to increased height of pulse, most later observers in this field have been able to demonstrate no essential difference between pleasant and unpleasant stimuli. As we shall see in the sequel, such a difference does nevertheless exist; and if authors like Kiesow, Shields and Binet are not able to find this, probably a whole series of interesting circumstances is at fault" (*Körp. Aeus. psych. Zust., 128*). Lehmann objects to Binet and Courtier's work that they investigated emotions and that children were observers. He suggests that the difference may have been overlooked by Shields. Lehmann gives four reasons for the paucity of rises in V with pleasantness. (i) It is difficult to set up strong feelings of pleasantness. (ii) Since the feelings are weak the curves must be represented very plainly, especially with reference to length and height of pulse, in order that small differences may be visible. (iii) The observer must be kept in a state of affective equilibrium. (iv) It is impossible to avoid active attention, which has the opposite expression of pleasantness. In reply to these reasons it may be said (i) that it is true that the objective expression of pleasantness is difficult to secure. Such, at least, has been the experience of the Cornell Laboratory.[1] But to attribute this difficulty to the weakness of the pleasantness during the experiment without valid reasons for the attribution and in face of the fact that in ordinary life pleasantness is easily excited is almost a question begging argument. (ii) This does not apply to V but merely to changes in length and height of pulse. (iii) This is undoubtedly true. (iv) This reason involves a discussion of the relation of attention to feeling, which is not within the province of this paper, and in the second place, although it may be a difficulty, Lehmann himself has proved that it is not insuperable, by the fact of his own curves.

III. Summary of Conclusions.

The fourth physiological symptom with which this paper is concerned, namely, depth of breathing, must remain the sole characteristic, the validity of which is not impugned either by our own results or those of other observers. As we have already said, with a few exceptions it is the universal characteristic of active attention. The position of this paper, therefore, with regard to the four physiological symptoms may be summarized in three theses.

(i) Changes in rates of P and R are brought about by the psychophysical process of sensation.

(ii) Every sensory stimulus (probably in proportion to its intensity) tends to produce a fall in V.

(iii) Inhibited R is a characteristic of active attention.

IV. Classification and Discussion of Equivocal Cases.

A classification and analysis of the equivocal cases brings out some interesting relations as to the sensitiveness to change

[1] *Cf.* Titchener, Exp. Psych., Instructor's Manual — Qualitative, 181, for a curve of pleasantness.

of the circulatory and respiratory functions. We assume that if either function reacts pliantly to the conditions of the experiment, there will be few equivocal cases. On the other hand, if the function is inert, there will be many equivocal cases. The following Table shows the total number of experiments in each sense department, together with the number of equivocal reactions of *P* and *R*.

TABLE V.

Stimulus	Equivocal Cases		Number of Expts
	R	P	
Masson disc	5	5	14
After-image	4	7	12
Radii of circle	2	5	10
Radii with intrinsic interst	1	2	7
After-image with intrinsic interest	3	5	7
Questions in philosophy	2	4	6
	17	28	56
Difference tone	1	4	8
Watch from out in	1	1	7
Watch from in out	1	1	5
End of tone	1	4	10
Counting beats	3	4	8
	7	14	38
Cold spots	1	1	8
Minimal pressure	2	1	4
Comparing size of cylinders	1	0	3
	4	2	15
Multiplication	2	3	7

The Table shows that there are fewer equivocal cases of *R* in the visual and auditory experiments than there are equivocal cases of *P*. On the other hand, there are more equivocal cases of *R* in the tactual group than of *P*. This result, if our assumption as to the meaning of an equivocal case is correct, means that the respiratory function is more sensitive to auditory and visual stimuli than is the cardiac function; but that the heart responds more readily to tactual stimuli than does respiration. The Table also shows that the total number of

equivocal cases with relation to the whole number of experiments is less in the tactual and auditory experiments than in the visual. The proportion is 45:57 for visual; 21:38 for auditory; and 6:15 for tactual. This fact would seem to indicate that both *P* and *R* respond less readily to visual stimuli than to tactual and auditory stimuli.

V. Remarks on the Experiments with Intrinsic Interest and on the Attitude Experiments.

It remains to say a word about the experiments with intrinsic and natural interest, and the 'attitude' experiments. The former experiments were suggested as a means of varying the central conditions of attention while the peripheral conditions remained the same. It was thought that if peripheral factors were the cause of the changes in rate of *P* and *R*, the case would be strengthened if it was shown that a wide variation of central conditions made no essential difference in the results. Of course, such a conclusion is valid only on the assumption that the central conditions would express themselves differently from the peripheral conditions. Apparently, the variation in conditions made no marked difference in result. The latter experiments were instituted with a view to showing whether it is possible for the same observer to give consistently different reactions to the same stimulus. If it were possible, it was thought that it would show a possible ground for the discrepancies with which the literature of the expressive method abounds. The changes in *V* and depth of *R* show no differentiation according to attitude. The reaction for the most part is fall in *V* and inhibited *R*. The rates of *P* and *R* for the indifferent attitude do not change consistently within the group, although the pulse shows an evident slowing. The active and the affective attitudes, however, are differentiated quite sharply by the changes in rate of *P*, which in the active attitude is faster (except one reaction), and in the affective attitude is slower.

VI. Concluding Remarks.

The writer, after consideration and in the light of all the facts, has felt under the necessity of saying that the method of expression as applied to the study of the feelings and of attention has failed. When one compares Lehmann's extravagant suggestion[1] with the actual state of this branch of Psy-

[1] "Sind alle diese Erscheinungen erst untersucht und ihre characterischen Aeusserungen festgestellt, so wird man am Plethysmographen ein wirkliches Psychoskop besitzen, einen Apparat, mittels dessen man mit nicht geringer Sicherheit den Gemütszustand einer Person zu diagnostizieren vermag." *Körp. Aeuss.*, etc., text, p. 216.

chology, one cannot but wonder at his temerity. If the position which the writer has taken with regard to the changes in rate of pulse and of respiration and in volume is correct, the plethysmograph will never serve as a psychoscope for the diagnosis of affective processes. And if by any means the method is rehabilitated, it will require more rigorous rules of use than have yet obtained, to secure results of any degree of certainty.

D. Appendix.

Table VI was made in support of the statement that a long series of investigations with the method of expression had ended in contradictory or negative results. The negative results are those of Shields, Binet and Henri, Binet and Courtier, Angell and Thompson and Bonser. The contradictory result is that of Külpe, as regards the rate of pulse in unpleasantness, and that of Gent, as regards rate of pulse for pleasantness. The height of pulse in pleasantness and unpleasantness is consistent for those who have observed it. But many have failed to observe it at all. Zoneff and Meumann alone find an opposition in rate of respiration between pleasantness and unpleasantness. Binet and Henri and Binet and Courtier found no differentiation. Lehmann found an increased height of respiration the characteristic of pleasantness in his earlier work. He does not confirm it in his second work. Zoneff and Meumann find the opposite change in height of respiration for pleasantness. For changes in *V* Lehmann agrees with himself and with Gent. Féré, apparently, has not published any affective curves. Angell and McLennan's results are not stated precisely enough for treatment. The other observers have either found vasoconstriction for all stimuli or they deny any kind of correlation.

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TABLE VI.

Investigator		Affection	Pulse		Respiration		Volume
			Rate	Height	Rate	Height	
Féré	1887	Pleasantness					+
		Unpleasantness					−
Lehmann	1892	Pleasantness		+		+	+
		Unpleasantness		−			−
Külpe	1893	Unpleasantness	−				
Mentz	1895	Pleasantness	−				
		Unpleasantness	+				
Shields	1895	Pleasant or unpleasant odors					−
Binet and Henri	1895	Pleasant or unpleasant emotions	+		+		−
Binet and Courtier	1896	All emotions pleasant or unpleasant	+		+		−
Angell and McLennan	1896	Disagreeable					− 90%
		Agreeable					+ ? %
Angell and Thompson	1899	Pleasantness or unpleasantness	No correlation				−
Lehmann	1899	Pleasantness	−	+			+
		Unpleasantness	+	−			−
Zoneff and Neumann	1901	Pleasantness	−		+	−	
		Unpleasantness	+		−	+	
Brahn	1901	Pleasantness	−	+			
		Unpleasantness	+	−			
Gent	1903	Pleasantness	±	+			+
		Unpleasantness	+	−			−
Bonser	1903	Affective stimuli					−

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ILLUSTRATIVE SERIES OF TWELVE CURVES.

All curves read from left to right. *A* and *B* are normal curves without stimulus. In *A*, only one tambour of the pneumograph was functioning; hence the small breathing curve. About ten seconds of the pneumogram and plethysmogram were lost at the beginning of *A*, because the writing styles were not in contact with the drum. *C*, *D* and *E* are reactions to the Masson disc. The reaction is represented by the space between the arrows. That part of the curve between the beginning and the first arrow is the normal period; that between the second arrow and the end is the recovery period.

F, *G* and *H* are auditory reactions. In *F*, the stimulus attended to was a watch tick. At 1, the watch was moved away from *O;* at 2, it was inaudible; the watch was then moved toward *O* until it became audible at 3. In *G*, the stimulus attended to was beats. At 1, the forks were actuated; at 2, *O* began to count the beats; at 3, the beats ceased to be audible. In *H*, the stimulus attended to was a watch tick. At 1, *E* began to move a watch toward *O;* at 2, *O* heard the watch; it was then moved away from *O*, until it became inaudible at 3.

I, *J*, *K* and *L* are reactions to tactual stimuli. The stimulus attended to in *I* and *K* was a cold cylinder; in *J* and *L*, von Frey's pressure hair.

By a mistake of the engraver, the curves, instead of being reproduced full-size, have been reduced one-half.